SCIENCE

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Contents

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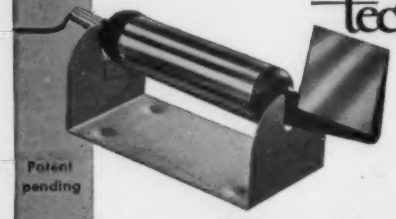

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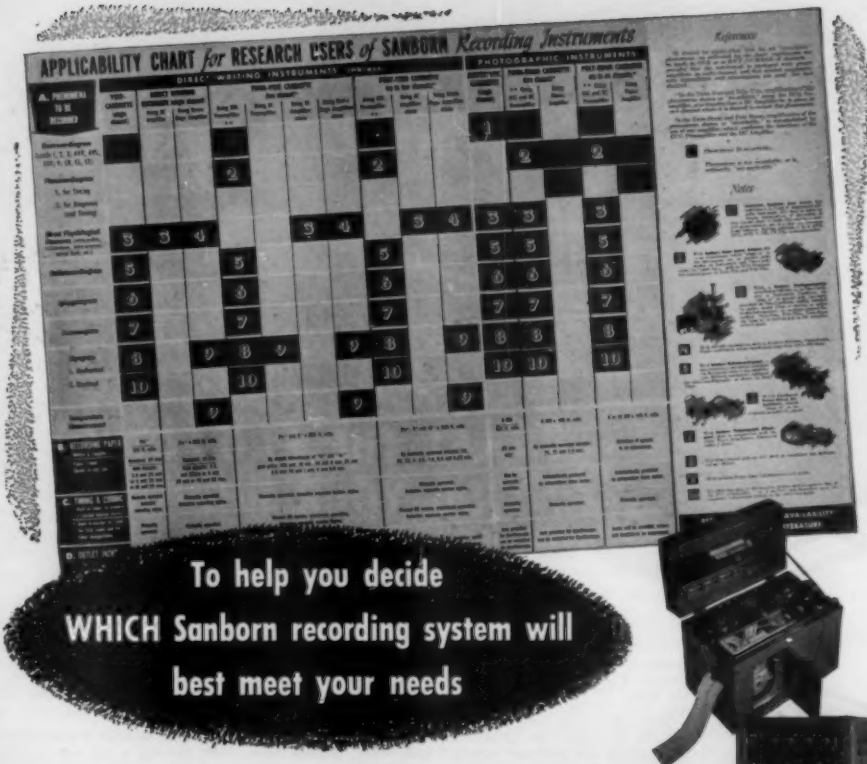

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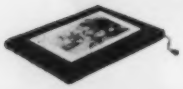

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American Archaeology

AT THE mid-century archaeology as a science is little more than 100 years old in the Americas. During this period it has been concerned with (1) systematic description, (2) historical ordering, and (3) functional understanding. Late nineteenth- and early twentieth-century investigators were primarily systematists in the description and classification of prehistoric cultural phenomena. After 1912 the temporal and spatial ordering of classified archaeological data (ceramics) was successfully demonstrated in the southwestern United States, and a disciplined historical approach was inaugurated. These innovations, borrowed in part from Old World archaeologists, established a trend that has been reinforced by the contemporary historical objectives in the allied field of ethnology. Since 1940, however, a third approach, the functional, has prompted an increasing demand for the understanding of cultural processes as these are revealed by, or inferred from, archaeological remains.

The historical approach has contributed most to American archaeology over the past 100 years, and systematic description and taxonomy have been largely the means to the ends of time-space reconstructions. The following conclusions seem to be especially noteworthy: First, the prehistoric past in the Western Hemisphere is directly ancestral to the American Indian cultures of the historic period, and no "mysterious lost race" is responsible for the earlier monuments and remains. Second, there is good evidence that the Americas were first peopled from Asia at the close of the Pleistocene, about 15,000 years ago, and that the aborigines had worked their way to Tierra del Fuego 5,000 years ago. Third, a rich American neolithic civilization or series of civilizations, based upon sedentary maize farming, developed somewhere between central Mexico and Peru as early as 1000 B.C. From these civilizations grew the classic New World states of the Maya, Aztec, and Inca, and basic neolithic influences spread as far northward as Utah and the Great Lakes, and as far southward as Chiloe Island and the Paraná River. Fourth, the interconnections between North and South America were through Central America; the West Indies were merely a cultural appendage of the South American mainland. Fifth, it is fairly certain that the cultural traditions of the southwestern and southeastern United States were developed in semi-isolation from Middle American centers and from each other, and that both areas had settled farming populations by the beginning of the Christian era. Moreover, a surprisingly complex ceremonialism, including large-scale earthwork construction, was present in the eastern United States at about this same time. Sixth, the ancestors of the colorful nineteenth-century seminomadic horsemen of the eastern plains of North America were settled village farmers as late as the sixteenth century. Seventh, the earliest known levels of Eskimo culture have an elaborate art style (later to disappear), with close affinities to Asiatic styles dating after the beginning of the Christian era.

For many of these substantial findings the aid of other scientific disciplines has been crucial. Dendrochronology (during the past 30 years) and carbon 14 analyses (during the past 5 years) have provided absolute datings of cultures, and geology and paleontology have solved many problems involving the early peopling of the Americas.

For all attempts at functional interpretations there is necessary recourse to historical data. In the North American Plains and elsewhere a study of acculturative processes has been possible on the basis of ethnohistoric-to-archaeologic sequences. In the eastern and southwestern U. S. correlations of natural environmental situations with culture types in sequence have given an insight into ecological adaptations. Long culture sequences in Middle America and Peru have provided the historical facts for developmental-functional interpretations. And in the southwestern United States settlement pattern, house-type, and house-content analyses are revealing a chronology of prehistoric social organizations. Recent critiques or appraisals of archaeological methodology indicate the need of a comprehension of process, as well as historical outline.

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Biological Control of Weeds in Compacted Soil Cultures

V. P. Sokoloff[1]

The Isaiah Bowman School of Geography
The Johns Hopkins University, Baltimore, Maryland

APPROXIMATELY $500,000 worth of irrigation water is lost annually from canals west of the Mississippi River because of the transpiration of weeds, notwithstanding the asphalt linings of the canals. The weeds, which are able to pierce such linings as well as thin linings of concrete, are a major problem in all irrigated agricultures, especially where water is conveyed in open canals over long distances.

Thick linings of concrete would prevent the weeds from growing through. Their cost, however, would be prohibitive, and their maintenance difficult. Application of arsenates, copper salts, and other herbicidal inorganic chemicals to soil supporting the flexible bituminous canal linings is an unpromising measure. Tolerance of weeds for such poisons requires rather costly applications; the herbicidal effects, if any, are apparently temporary; finally, there is a strong opposition to such pretreatment of the soil among the users of water, however unreasonable this opposition may appear to be. Certain organic compounds, notably derivatives of benzene, are capable of destroying weeds economically and rapidly.[2] Unfortunately, they do not attack the seeds and must be used frequently and repeatedly. Technological research may still result in the discovery of a cheap weed-resistant material for the canal linings, or of effective, enduring, and unobjectionable herbicidals for the sterilization of the soil. Developments are slow, however, and disappointments are too numerous to be stimulating.

Such is a rough outline of the problem as I learned it from R. S. Rosenfels and John S. Shaw, in 1947, in Denver. Its biological aspects reminded me of some earlier findings in California,[3] confirmed subsequently by later investigators.[4]

These earlier studies dealt with susceptibility of feeder roots to certain pathogenic fungi developing in consequence of stresses induced in the respiratory system of the plants through exposure to weak poisons or to mechanical-physical shock. Plants so conditioned would yield to parasites or pathogens, which they could resist successfully as long as stress or shock was avoided. The state of susceptibility induced in the plants was temporary. A large number of plant species responded to the conditioning in about the same manner (citrus, avocado, walnut, corn, wheat, tomato, radish, lettuce, cauliflower, etc.), whereas the nature of the pathogen seemed relatively unimportant. An inference from these earlier findings was reasonable:

If such a state of susceptibility could be induced and maintained economically in the germinating seeds of noxious weeds, the problem of weed control in the field would be on its way to a satisfactory solution. The testing of this hypothesis was carried out as follows:

Test plants. Smooth brome grass, yellow sweet clover, buffalo grass, crested wheat, and Great Northern beans were chosen as test plants for the experiments. The first four are common weeds in Colorado and elsewhere; the beans were used because of their vigorous growth and their previously observed capacity to penetrate almost any bituminous lining and to split thin linings of concrete. My earlier and later observations lead me to believe that practically any plant, wild or cultivated, would respond in about the same way to the succession of regimes described below. The seeds were a part of Mr. Shaw's collection and were of excellent quality, yielding practically 100 per cent germination in test lots.

Soil. The humous A horizon of an alluvial soil from the banks of an irrigation canal, Denver Federal Center, was the test material. The soil was a dark-gray, heavy, silty clay loam to clay loam with a chernozem-like structure and a pH of 7.4 in 1:1 aqueous suspensions. This is one of the fertile soils of the area, and it supports an abundant growth of weeds and also of volunteer oats, alfalfa, wheat, etc. Its compaction characteristics are unfavorable because of the relatively high silt content. The choice of this particular soil for the experiments was determined by its unfavorable properties from the point of view of weed control. If positive experimental results were obtained with this control-resistant material, one

[1] I am indebted to the administrative officers of the U. S. Bureau of Reclamation at the Denver Federal Center for their hospitality, to R. S. Rosenfels (now of Richland, Wash.), and to John S. Shaw for their interest and active participation in the studies, and to many others of the bureau's staff for aid and advice. I am indebted also to G. F. Carter, chairman of the Isaiah Bowman School of Geography, The Johns Hopkins University, for his interest in and encouragement of these studies; to C. F. Miller, of the School of Engineering, for his enlightened comment; and to H. Bentley Glass, of the Department of Biology, for his interest in and criticism of the paper.

[2] John S. Shaw, U. S. Bureau of Reclamation, has met with some success in this method.

[3] Sokoloff, V. P., and Koltz, L. J. *Calif. Citrograph*, **28**, 290, 308 (Nov. 1943); Klotz, L. J., and Sokoloff, V. P. *Citrus Leaves*, **23**, 1, 22 (1943).

[4] Curtis, D. S., Chapman, H. D., and Zentmyer, G. A. *1949 Yearbook*. Calif. Avocado Soc., 155.

would be encouraged with respect to less difficult soils.

In earlier, unpublished work, I observed nearly the same response of plants to the treatment shortly to be described on soils ranging in texture from sand to clay, as well as on peat, muck, gravel, and in water cultures—in short, throughout a wide range of test materials and conditions, as long as certain basic features of the treatment remained the same.

Containers. Cylindrical tin cans were preferred to other containers in our tests, chiefly because of their suitability for the mechanical compaction treatment. The inside diameter of the cans was 5.1 inches; their inside depth, 5.9 inches; their volume, 155 cubic inches; and their capacity, about 8 pounds of compacted soil at 100 pounds per cubic foot.

Chemicals. Chemically pure nitrates of calcium and potassium, glucose, and sodium phosphates were used as aqueous solutions in distilled water. In the second series of tests, cane molasses was substituted for the glucose and tap water for distilled water. Only refined, table-quality cane molasses (Brer Rabbit) was available at the time, which was somewhat regrettable, although the results here reported are not affected by quality of the molasses. My preference for the crudest and cheapest cane molasses was determined not only by the successful results previously obtained, but by its low cost. As a matter of fact, any carbohydrate waste such as sweet-potato peelings or sugar-beet refuse would yield about the same results. The common impurities in low-grade molasses, both mineral and organic, are desirable in the control of weeds. The usual variations in their content are unimportant. Their presence serves to obviate the necessity of adding essentially the same substances to the enrichment cultures.

The following sequence of environments in soil cultures is generally conducive to the attainment of our purpose—namely, the prevention of weed growth:

Reduction of pore space to the practical minimum. This is accomplished by compaction in the presence of moisture optimal for the purpose. The function of moisture is to serve as a lubricant enabling soil particles of various sizes to slide into spaces or interstices between other particles. There is a maximum compaction for any given soil, corresponding to a certain minimum pore space, beyond which it is not possible to go. In this particular case the optimum compaction moisture was determined to be 21.7 per cent, and the maximum attainable density, 90–100 pounds per cubic foot, corresponding to about 40–46 per cent total pore space on a volume basis. Some sandy soils may be compacted to 125 pounds per cubic foot, corresponding to only 24 per cent total pore space, assuming the true density of the soil substance to be 2.65.

The effect of compaction is to reduce the total pore space to about two thirds of its original proportion and accordingly to influence adversely the aeration of seeds during their germination. The physical effect of the compaction is to increase the mechanical stability of the ground and to render it better suited for the linings or pavement to be imposed.

Compaction alone is insufficient to prevent the germination of seeds, however, with or without the asphalt capping of the cultures.

Further interference with respiration of germinating seeds. An economic way rapidly to exhaust oxygen in the soil air is to encourage bacterial growth in the soil by enrichment with certain added materials. The choice of the type of growth to be encouraged and, accordingly, the choice of materials to be added are determined by the following considerations:

1) The bacteria should be a common ubiquitous group, facultatively anaerobic, with simple nutritive requirements, mesothermal, and nonpathogenic to man and animal.

2) The group in question must *not* be effective fermenters of carbohydrates or producers of acid. In other words, the anaerobic metabolism of the bacterial group to be enriched should be such as not to allow rapid and significant changes in the volume of the gaseous phase of the confined soil, in order to protect the bituminous cap.

3) The anaerobic growth of bacteria to be enriched should be conducive not only to the deprivation of the germinating seeds of oxygen but also to a production of poisons, however mild, further to facilitate the destruction of the germinating seeds.

4) The organic substratum of the desired bacterial group should be cheap, harmless to man and animal, and noncorrosive to the bituminous linings.

It is evident that only one group of soil microorganisms satisfies the enumerated conditions, namely, the heterotrophic, facultatively anaerobic denitrifiers—that is, the reducers of nitrate capable of using organic substances as donors of hydrogen.[5]

The reduction of nitrate has been shown[6] to take place in the following well-defined steps:

$NO_3^- + 2H = NO_2^- + H_2O$; i. e., nitrate to nitrite
$NO_2^- + 2H = NO^- + H_2O$; i. e., nitrite to hyponitrite
$2NO^- + 2H = N_2 + 2OH^-$; i. e., nitrate to nitrogen gas[7]

Denitrification may be arrested at either the nitrite stage or the hyponitrite stage by controlling the proportion of the hydrogen donor (i.e., the carbohydrate substance) to the hydrogen acceptor (i.e., the oxidized forms of N), preventing thereby the evolution of gaseous nitrogen. As to the carbon dioxide and its derivatives produced during the denitrification, the bulk of the gas may be immobilized in the soil, in the slightly alkaline optimum range of the reaction and in the presence of calcium.

The gaseous economy of the denitrification may be

[5] The taxonomy of this large group is unknown. The *Bacillus denitrificans* of standard manuals, monographs, etc., covers a multitude of things. My collection of denitrifiers in Riverside, Calif., in 1940–43, contained more than 60 species, mostly unidentified, with many more remaining to be isolated.

[6] "Report on Bacterial Denitrification." University of California Citrus Experiment Station files (1941). See also Elema, B. *De Bepaling van de Oxydatie—Reductiepotentiaal in Bakteriencultures en hare Beteekenis voor de Stofwisseling.* Delft: (1931).

[7] The third stage, hyponitrite to nitrogen gas, is established by measurements of NO^- and N_2 as well as of OH^-. The pH optimum for this last stage of the denitrification is on the alkaline side of 7.

TABLE 1

EFFECTS OF COMPACTION, CAPPING, CARBOHYDRATE, AND NITRATE ON GERMINATION OF SEEDS IN SOIL CULTURES AND ON DAMAGE TO CAP BY PLANTS OR GAS

Treatment				Response								
				Germination					Damage to cap			
Compaction	Cap	Carbohydrate	Nitrate	Brome	Buffalo	Clover	Wheat	Beans	By plants	By gas	No.	C:N
		(% of soil)		(Number of seeds per 10)								
+[a]	+	10.0	1.2	—	0[†]	—	0	0	0	+	17	34
+	+	7.7	1.8	—	0	—	0	0	0	+	18	17
+	+	5.5	2.4	—	0	—	0	0	0	+	19	9
+	+	3.1	2.8	—	0	—	0	0	0	0	20	5
+	+	2.2	3.1	—	0	—	0	0	0	0	21	3
+	+	1.2	3.3	—	0	—	0	0	0	0	22	2
+	+	0.6	3.4	—	0	—	0	0	0	0	23	1
+	+	0	0	—	7	—	5	8	+	0	24	—
+	0	0	0	—	9	—	8	10	+	0	25	—
0	0	0	0	—	8	—	6	10	+	0	30	—
0	+	0	0	—	9	—	8	10	+	0	31	—
0	0	0	0	10	8	6	5	—	+	0	1	—
0	0	0	0	10	7	5	5	—	+	0	2	—
0	0	0.6	0.5	3	3	0	0	—	—	—	5	4
0	0	0.6	0.5	9	0	0	0	—	—	—	6	4
0	0	0.6	0	8	3	6	0	—	—	—	9	—
0	0	0.6	0	8	6	3	4	—	—	—	10	—
0	0	0	0.5	5	0	0	2	—	—	—	13	—
0	0	0	0.5	6	0	0	0	—	—	—	14	—
0	+	0	0	2	2	1	1	—	+	0	3	—
0	+	0	0	3	3	1	2	—	+	0	4	—
0	+	0.6	0.5	0	0	0	0	—	0	0	7	4
0	+	0.6	0.5	0	0	0	0	—	0	0	8	4
0	+	0.6	0	0	0	0	0	—	0	+	11	—
0	+	0.6	0	0	0	0	0	—	0	+	12	—
0	+	0	0.5	6	5	0	1	—	+	0	15	—
0	+	0	0.5	5	1	0	1	—	+	0	16	—

[a] + means "treatment applied."
[†] 0 means "treatment not applied" or "absent."

controlled, therefore, by the proportion of the carbohydrate to the nitrate and by the pH of the system. For all practical purposes the carbohydrate-nitrate ratio is not critical, provided it remains below a certain threshold. This threshold is not affected by the nonnitrate nitrogen of the system. In our particular case the threshold corresponds to the weight ratio of molasses to $Ca(NO_3)_2$ as, roughly, 2:3 (Table 1).

An important consequence of the anaerobic metabolism of the denitrifiers is an impairment of the respiratory mechanisms of small roots in contact with the culture. It is this additional effect, accompanying the withdrawal of oxygen from the soil air by the facultative anaerobes, that seems to contribute to the collapse of the germinated seeds.

Secondary invaders. It has been observed consistently that young rootlets and germinating seeds become overgrown by fungi in soil cultures previously enriched with respect to the denitrifying bacteria. The fungi appear to be parasites or saphrophytes as well as mild pathogens, such as the brown root rot species.

The importance of this last stage of visible destruction of germinated seeds remains to be ascertained.

The experiments were carried out as follows:

a) The stock of soil, *ca.* 200 pounds, was screened to remove gravel and plant roots, mixed, and stored in a wooden bin. The air-dry moisture content of the stock was 3.5 per cent.

b) Eight-pound aliquots of the stock were brought to the optimum compaction moisture of 21.7 per cent, placed in the tin cans, and compacted, in layers, to maximum density.[3]

c) Seeds were planted as described in Table 1 and covered by soil five times as thick as the seed's largest diameter. The soil covering the seed was recompacted, to restore the original surface.

d) The asphalt caps were poured over the compacted soil, with care to keep the temperature at the minimum.[3]

e) Condition of compacted cultures, plant growth, etc., were observed daily.

f) After 23–83 days the experiments were discontinued; the asphalt caps were removed and examined for damage; condition of seeds was ascertained, together with the pH of the incubated soils and other changes in the cultures.

A summary of observations is given in Table 1. The extent of compaction was between 90 and 100

[3] I am indebted to the Soils Laboratory of the U. S. Bureau of Reclamation for these operations. See *Earth Materials Test Procedures* (rev.), Denver: USBR (1948).

pounds per cubic foot. Thickness of the asphalt cap, 30–40 pen., was ¼ inch in all cases. The carbohydrate was supplied as cane molasses in Nos. 17–31, and as glucose in the others; nitrate, as $Ca(NO_3)_2$ in Nos. 17–31, and as KNO_3 in the others. The number of seeds planted in staggered rows was 10 of each kind, but 8 for the beans. The injury of the asphalt cap was by a direct penetration of the germinated seed, by pockets of gas trapped in the bituminous substance, and, in Nos. 17, 18, and 26, by a disturbance of the soil surface under the cap. "0" damage means a complete absence of visible damage of any kind.

The C : N ratio is the atomic ratio of carbon in the carbohydrate to nitrogen in the nitrate, assuming 1 gram-atom C per 41 g of molasses or per 30 g of glucose and 1 gram-atom N per 82 g $Ca(NO_3)_2$ or 101 g KNO_3.

Nos. 17–31 were unbuffered, except by the added materials. The others were buffered at pH 7.4 at 0-time, with the aid of 5 millimols of a phosphate buffer per can. All materials added were introduced with the moisture used at the time of the compaction.

Nos. 17–31 were examined after 83 days of incubation; the others, after 23 days. The loss of moisture was not appreciable from either the capped or the uncapped cultures. There was some evidence of alcoholic fermentation in Nos. 17, 18, and 26—the only cultures where pH of the soil fell to 6.3–6.8 after the incubation. The pH of the others ranged from 7.0 to 8.4. There was no evidence of precipitation of $CaCO_3$.

The problem of weed control along canal embankments lined with bituminous materials is posed rather than solved in the present report, despite the rather spectacular positive results obtained in the laboratory. A complete solution of the problem in the field could not be carried out because of the lack of time, funds, and interest. A detailed laboratory investigation of the possibilities here demonstrated could not be undertaken for the same reasons, plus the lack of facilities for the microbiological research. It is my hope, however, that the present beginning may stimulate further studies by interested agencies or individuals.

Field tests should not be difficult, once the optimum treatment schedules could be established in the laboratory. Assuming an establishment of such schedules, the field practice will require attention chiefly with respect to the following probable difficulties:

1) Reproducibility of results obtained in closed systems in the laboratory, in systems only partially confined as in the field. There should be no difficulty in applying the carbohydrate-nitrate mixtures to soils undergoing compaction or in controlling rather nicely the amounts and the distribution of the solutes in the soil. The existing machinery and skills are adequate for the purpose. The real difficulty is likely to arise with the stability of the oxygen-impoverished carbohydrate and nitrate-enriched environment in the compacted root zone under the linings. This problem can be solved only empirically. Regardless of the kind of leads or solutions obtainable in the laboratory, only a series of field trials could justify the economic application of the method.

2) Stability of the herbicidal effects in the field environment likewise needs to be ascertained. In my view, there are reasons in favor of the presumption of this stability, provided the compaction and the stabilization are performed with care sufficient to minimize seepage, capillary exchanges of moisture, and the gaseous exchanges between the enriched compacted zone and its periphery. Here, again, only a series of field trials can ascertain this possibility.

3) Costs of materials and treatments were not considered in this study. This aspect of the problem would be critical in the field. Granted the locally low cost of crude cane molasses, for example, there is no reason to limit oneself to this particular source of carbohydrate. There may be cheaper sources. In fact, practically any carbohydrate can be employed in the method proposed here.

The effects and the relationships observed have significance in many fields of biological knowledge. The underlying mechanisms are suggested plausibly but not proved conclusively. Their proof lies in the biochemical fields now only partially or wrongly developed. For example, the conventional line of research involving isolations of organisms, "pure-culture" studies, single-substance effects, isolation of "pure substances," etc., leads more often than not into blind alleys, wherein contact with nature is sacrificed to conformity with unrealistic standards of the epigoni.

The relative sterility of modern soil microbiology is due to the neglect of mixed culture studies and to the adherence to the postulates of Koch, so useful in their day, but already transcended, in part, by modern medicine.

In our problem we are dealing with more or less controlled cultures, mixed and impure, and with susceptibility-resistance phenomena in germinating seeds, which are understood but imperfectly; with shifting balances between components of soil populations; and with delayed effects and aftereffects of factors and substances remaining to be ascertained. The technological problem posed is of a field engineering type, where the method must fit the need. In this study it has been observed that (1) seeds of brome grass, buffalo grass, yellow sweet clover, crested wheat, and beans can be largely prevented from germination and the growth of germinated seeds can be effectively arrested in compacted asphalt-capped soil cultures receiving a mixture of carbohydrate-nitrate, under certain conditions; and that (2) the evolution of gas in the carbohydrate-nitrate enriched cultures can be minimized by a control of the C : N ratio in the soil solution whereby the asphalt capping remains unimpaired.

These laboratory findings may be useful in the biological control of weeds in irrigation canals, and field tests to determine their utility appear to be in order.

Technical Papers

Absorption Spectra of Chlorophylls in Solutions at Low Temperatures—Equilibria between Isomers[1]

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The refinement in spectra that accompany a reduction in temperature prompted us to measure the absorption spectra of solutions of chlorophyll *a*, chlorophyll *b*, and chlorophyll *b'*[2] over a range of temperatures from room temperature (300° K) to that of liquid nitrogen (75° K), somewhat below the boiling point.

The spectra of the solutions of chlorophylls *a* and *b* at room temperature were the same as have been accepted in the literature (*1*). That of chlorophyll *b'* had been found (*2*) to be practically indistinguishable from the spectrum of chlorophyll *b*, and with this description our spectra at room temperature are in agreement except that in the spectrum of chlorophyll *b'* 4 weak bands in the ultraviolet region are superimposed on a greater general absorption than is exhibited in this region by chlorophyll *b*.[3]

The solvent employed for all the chlorophylls at low temperatures[4] consisted of about 20% by volume di-*n*-propyl ether, 40% propane, and 40% propene, and the solvent for temperatures above 230° K consisted of 20% of the ether and 80% *n*-hexane.

In general, it may be observed from Figs. 1 and 2 that the spectra of the solutions are shifted toward longer wavelengths as the temperature is reduced and concurrently new band maxima make their appearance or become more noticeable. In each spectrum the strong absorption peak in the blue region and the neighboring structure toward shorter wavelengths are most responsive to changes in temperature. The weak peaks of chlorophyll *a* on the short wavelength side of the prominent red absorption are also temperature-sensitive. Although at first glance the spectra of the chlorophylls at 75° K differ from their spectra at 230° K chiefly by a shift in wavelength, most of this shift was found to be apparent only, since at intermediate temperatures one spectrum disappears and at its expense a similar spectrum makes its appearance—toward longer wavelengths as the temperature is reduced. Figs. 3 and 4 show the change of the blue bands on an enlarged wavelength scale.

Since the structures of the spectra of the high and low temperature modifications are closely similar, they may be ascribed to isomers that appear to be in equilibrium. The same spectra were observed at a given temperature with both falling and rising temperatures.

However, the changes in the form of the spectra of chlorophyll *a* are not so sharply differentiated as are those of chlorophylls *b* and *b'*. The latter two, barely distinguishable at room temperature and also at our lowest temperature, 75° K, show large differences at intermediate temperatures because the energies of the isomeric transformations have proved to be substantially unequal. The isomers of chlorophyll *b* coexist in equal amounts at 180° K (Fig. 3), whereas those of chlorophyll *b'* reach equality at 230° K (Fig. 4). The isomers of chlorophyll *a* are present in equal concentrations at about 180° K.

Several definite structural features in the spectra of chlorophyll *b* varied with different preparations, made in supposedly the same way (Fig. 2). Especially marked were the extent and sharpness of the shoulder on the long wavelength side of the blue peak—at 4,815 A (77° K). Accompanying this was a small band on the short wavelength side of the red peak—at 6,300 A (77° K). Along with these features the shape of the peak at 4,500 A varied with preparation.

Experiments were undertaken to discover whether such differences could possibly be experimental artifacts. For example, the thermal treatment of the solution was varied from sudden quenching to extremely slow cooling from room temperature to 77° K. On the possibility that in the evaporation of the original solvent the ethyl ether may not have been completely removed, quantities of di-ethyl ether were added to the di-*n*-propyl ether. All our trials ended with solutions that continued to give identical spectra. The spectrum of pheophytin was also examined to eliminate it as a

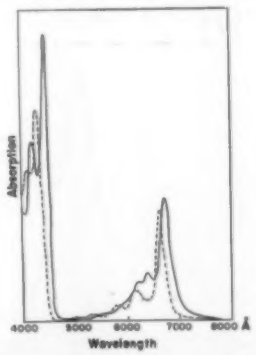

FIG. 1. Visible absorption spectra of solutions of chlorophyll *a* at 230° K (- - - - - - - -) and at 75° K (————). Concentrations are different at the two temperatures.

[1] Work was performed under the auspices of the Atomic Energy Commission.

[2] The chlorophylls were prepared and purified by Robert Livingston and his associates at the University of Minnesota (ONR Project N 60 ri-212 Task Order I). We are deeply grateful to them for their assistance and cooperation throughout the progress of this work.

[3] We learned from a private communication that Robert Livingston and his associates had previously observed some difference in the ultraviolet spectra at room temperature.

[4] For method of preparing solutions, see S. Freed and C. J. Hochanadel, *J. Chem. Phys.*, **17**, 664 (1949).

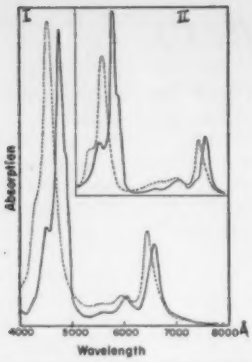

FIG. 2. Visible absorption spectra of solutions of chlorophyll *b* at 230° K (- - - - - - - -) and at 75° K (————) for preparations I and II. Concentrations are different at the two temperatures.

possible impurity. Finally, with the cooperation of Professor Livingston, the purified chlorophyll *b* on the chromatographic adsorption column was removed in 3 fractions. The spectra of these fractions succeeded only in showing that the lowest fraction on the column consisted of considerably more chlorophyll *b'* than had been suspected, whereas the other 2 fractions gave the same spectra at each temperature. Neither of them furnished the shoulders and associate features as sharply and definitely as had been exhibited by a preparation of chlorophyll *b* made several months earlier. We are forced to conclude that there exists at least one other component in chlorophyll *b*, with a probably similar spectrum that has hitherto not been isolated by this process.

Insufficient work has been done to determine the nature of these isomers. The accepted chemical structures of the chlorophylls allow for a number of possible isomers: first, in the enol-keto forms and, second, in the different mutual configurations about the 3 asymmetric carbon atoms. The rate of transformation of one isomer of chlorophyll *b* into the other was rapid even at the lowest temperature 150° K at which the new isomer was first detected as the temperature was raised. At any fixed temperature no increase in its concentration was noted with time. However, a rise in temperature brought in at once an increase in the intensity of the spectrum of the high temperature form.

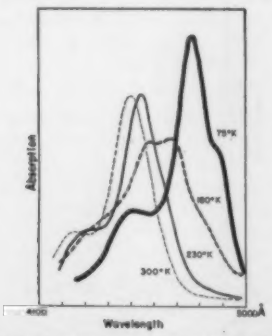

FIG. 3. Changes with temperature of the absorption spectra of the isomers of chlorophyll *b* in solution.

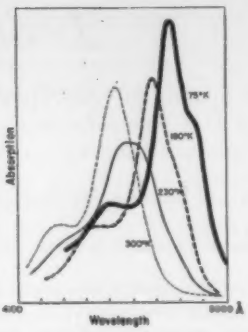

FIG. 4. Changes with temperature of the absorption spectra of the isomers of chlorophyll *b'* in solution.

As the spectrum of the low temperature form begins to grow in, it modifies the over-all spectrum in a way that suggests the differences in appearance at room temperature of the spectra of chlorophylls in different solvents, especially in the 4,100 A to 4,300 A region (*3*). It is to be expected that the character of the solvent affects the energies of the isomeric transformations, especially if they are of the enol-keto type, and hence we are led to ask whether the difference in the spectra of the chlorophylls in different solvents may not be largely due to the change in the relative concentrations of the isomers present. Similarly, the well-known change in color of chlorophyll when it is adsorbed may to an appreciable degree be a shift in the equilibrium between the isomers induced by the adsorption process.

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The Pulmonary Circulation as a Source of Leucocytes and Platelets in Man

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The intravenous administration of epinephrine in man is followed by an immediate leucocytosis and thrombocytosis, the source of which has been variously attributed to the spleen and/or the bone marrow

[1] Damon Runyon fellow.
[2] Resident in medicine.

(*1–3*). However, leucocytosis and thrombocytosis following epinephrine have been observed in splenectomized patients (*4*), and it is doubtful that the bone marrow is capable of immediately delivering such large numbers of leucocytes and platelets into the circulation. As part of an investigation of the hematological role of the lung, 0.1–0.2 mg of epinephrine was administered intravenously to several patients with metastatic neoplastic diseases. By frequent sampling of blood from intravascular catheters placed in the right ventricle and an appropriate large artery, it was observed that the increase in number of leucocytes and platelets in the arterial samples preceded and exceeded that found in the venous blood by at least one to two circulation times (Fig. 1). The arterial-venous platelet difference was more marked and sustained than the leucocyte difference.

It would thus appear that the pulmonary circulation in man may act as an available source of leucocytes and platelets, which may be delivered rapidly into the peripheral circulation under the stimulus of intravenous epinephrine administration. The lung, therefore, must also be considered to contribute significantly to the leucocytosis and thrombocytosis following epinephrine in some patients under these conditions. Likewise, the pulmonary circulation warrants careful study in neutropenic and thrombopenic states that are not completely explained by current theories. These data do not prove that platelets are produced in the human lung, as has been suggested by the studies of Howell and Donahue (*5*) in the dog, but merely illustrate that in some patients without panhematopenia, the lung may be stimulated to deliver platelets promptly into the circulation. The continued discrepancy between the arterial and venous platelet number suggests removal of some platelets in the peripheral circulation. Details of these studies will be published elsewhere.

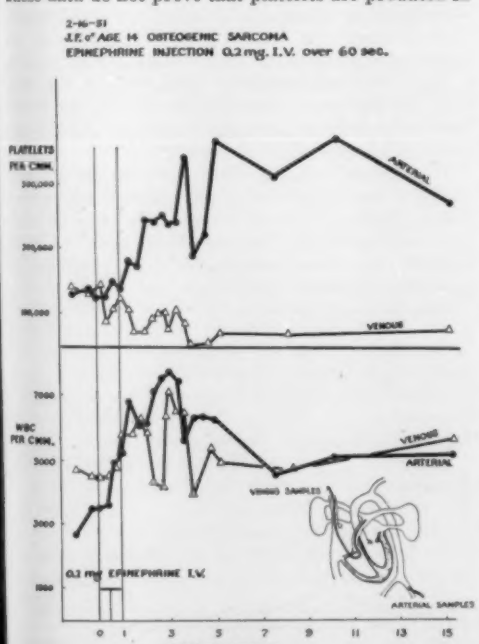

FIG. 1. Venous samples from the pulmonary conus; arterial blood from the femoral artery. There was no significant change in the red blood count in either arterial or venous blood throughout the period of study.

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Effects of Male Hormone upon the Tail of the Slider Turtle, *Pseudemys scripta troostii*

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It is during the fourth or fifth year, usually, that the male slider turtle attains sexual maturity, as indicated by the presence of sperm in testes or vas deferens. At this time the tail grows rapidly and becomes notably longer than that of the female (*1*).

The manner in which the tail of the male is utilized in preliminary courtship (*2*) and in mating (*3*) has been described. The greater length of tail is necessary to consummate the mating process, since the length of the plastron of the male averages 13.5 cm, whereas that of the female averages 18.9 cm (based upon measurements of more than 800 specimens of each sex examined [*4*]). Measurements of the tails of skeletons of *Pseudemys* at the American Museum of Natural History also reveal that the tail of the male is definitely longer than that of the female, despite the fact that the same number of caudal vertebrae occurs in both sexes (24 ± 5).

It would thus appear that the greater length of the tail of the male slider represents a secondary sexual character and that it is subject to control by the male sex hormone. This is confirmed by the experiment to be described.

Two groups of juvenile sliders were secured for study. One averaged 5.5 cm plastron length, the other 3.5 cm. Ten of each group received pellets of testosterone propionate[1] (6.5 mg and 4.0 mg, respectively) in September 1948. Ten others of each group were retained as controls and were kept in separate aquaria. All specimens received similar care and food. Mortality averaged 20% among the larger specimens and 30% among the smaller, with no greater loss recorded among the treated turtles than the controls. The experiment was terminated in May 1950, when all animals then living were sacrificed.

[1] Generously supplied by Ciba Pharmaceutical Products.

FIG. 1. Tail of juvenile turtle, treated with male hormone. ×4. X-ray photographs by Photographic Department of The American Museum of Natural History.

Despite the fact that the animals received citrus juice, cod-liver oil, and bone meal in addition to fresh beef and fish, the ossification centers of the tails of the smaller treated turtles failed to show in the x-ray photos. The soft tissues of the tails of the latter, however, responded like the larger ones to endocrine stimulation, with a comparable degree of hypertrophy.

Fig. 1 shows an x-ray photo of the tail of a turtle (plastron length, 5.5 cm) that had received 6.5 mg of testosterone propionate in September 1948 (sacrificed, May 1950). The out-bulging structure is the shadow of the penis, which was hypertrophied to such a degree that it could not be retracted into its sheath. Not all treated individuals exhibited a comparable enlargement of the penis. It was presumed that only males showed such precocious genital development. All treated specimens displayed similar tail enlargement, however. Fig. 2 portrays the x-ray shadow of the tail of a turtle (plastron length, 5.5 cm) that served as a control.

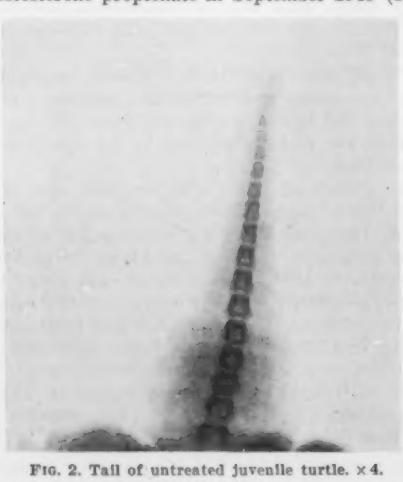

FIG. 2. Tail of untreated juvenile turtle. ×4.

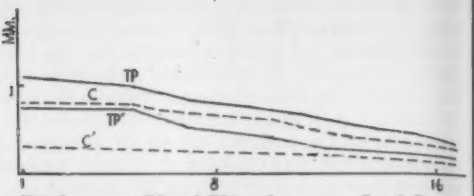

FIG. 3. ———, TP and TP^1, and — — —, C and C^1, represent the vertebrae and intervertebral spaces, respectively, of (1) juveniles treated with male hormone; and (2) those of untreated juvenile controls.

Figs. 3 and 4 compare graphically the dimensions of caudal vertebrae and intervertebral spaces in juvenile and adult sliders. In both figures the upper two graphs indicate vertebrae, the two lower (δ', φ', and C', TP'), intervertebral spaces. In Fig. 3 the structures of juvenile sliders treated with male hormone are compared with those of juvenile controls. Fig. 4 compares corresponding structures of adult male and female sliders. There is a relatively close similarity in the graphs pertaining to the adult female and the juvenile control. The same similarity holds between the adult male and the treated juvenile, but it is masked by the unequal growth of particular vertebrae, which occurs prior to the attainment of maturity.

It is possible that if older juveniles, or a longer period of endocrine stimulation, had been used a more precise duplication of the natural male hormone might have been achieved. However, there seems to be no doubt that the tissue constituents of the slider tail are markedly responsive to male hormone.

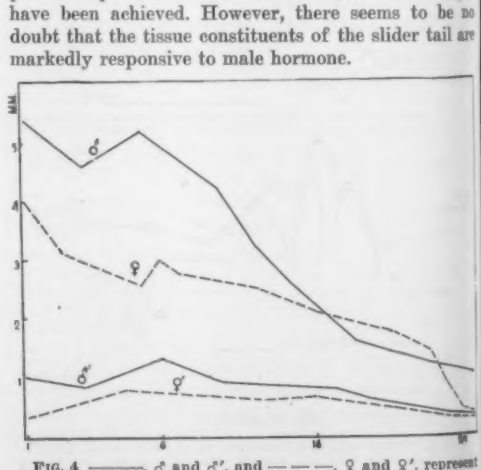

FIG. 4 ———, δ and δ', and — — —, ♀ and ♀′, represent the vertebrae and intervertebral spaces, respectively, of (1) adult males, and (2) adult females.

All the juvenile specimens that received testosterone propionate pellets also exhibited unusually long claws on the second, third, and fourth digits of the forefeet when sacrificed. This confirms a previous report (*5*) that male hormone induces hypertrophy of the second, third, and fourth foreclaws of juvenile slider turtles. Cagle (*3*), Conant (*6*), and Taylor (*7*) have indicated the manner in which the elongated foreclaws of the male slider are utilized in the preliminary phase of courtship. It has also been noted that at sexual maturity these foreclaws exceed in length those of the adult female by at least 2.5 times (*1*). It is thus evident that the middle foreclaws of the male slider, as well as the tail, represent secondary sexual characters.

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Microspectrophotometry and Cytochemical Analysis of Nucleic Acids

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The technique of microspectrophotometry, a recently developed method of cytochemical quantitative analysis whereby the spectral transmittance of a minute part of the cell nucleus is measured, can be improved from the photometrical point of view. Many workers (*1–5*), illuminate a large area of the microscopic tissue section, including the part to be measured, and select the light by a diaphragm placed at the image plane of the photomicrographic system. Owing mainly to internal reflections in the magnifying optical system, the light passing through the adjacent area of the minute part in the tissue section may cause a stray light that is added to the image of the part in question, so that the measured value of the transmittance may be enhanced. The effect, which is especially remarkable when the transmittance of the minute part is small compared with the outer illuminated area, is known in microdensitometry of photographic images of stars and spectral lines as the Schwarzschild-Villiger effect (*6,7*).

In order to reduce this effect, we have illuminated the minute part in question only, as is usually done in precision microdensitometry. Our illuminating optical system consists, as shown in Fig. 1, of a photomicrographic system that is the same as that used for magnifying, but with the reversed direction of light. An iris diaphragm of variable diameter (2–10 mm), which serves as the light source, is imaged with a reduction to 1/2000 by the system, and only a section 1–5 μ in diameter is illuminated. As ordinary microscopic condensers are not suitable for this purpose because the corrections of aberrations are insufficient, a Zeiss objective 1/12 (oil immersion) is employed. The problem of its short working distance is overcome by using a thin cover glass for the tissue section. The magnifying part of our optical system is the same as usual, with a second iris diaphragm placed at its image plane to cut out the remaining stray light, thus introducing to the photoelectric tube light from the minute part in question free from the Schwarzschild-Villiger effect. A second optical path from the light source to the phototube (Fig. 1) furnishes a check on the variation of the intensity of the light source during the measurement.

Our system has proved to be especially useful in the quantitative analysis of nucleic acids in a cell nucleus of spherical form. When the reduced image of the light source is formed at the center of a small transparent sphere, and when the dimension of the image is sufficiently small compared with the diameter of the sphere, then the length of the optical path of any beam of light passing through the sphere is the same as, and is equal to, the diameter of the sphere, being independent of the inclination angle of the beam to the optical axis, as shown in Fig. 2. Therefore, if the sphere is made up of a solution, we can determine exactly the concentration c of the solution by the formula

$$T = e^{-\varepsilon c(2r)}$$

by measuring the radius r and the transmittance T of the sphere by our system, provided that the extinction coefficient ε of the solution be known.

The following experiment has been made to exemplify the above theory. Various small spheres of 0.030 *M* aqueous solution of safranin, 2–30 μ in diameter, were prepared by mixing and agitating the solution with cedar oil; their transmittances for a monochromatic light (λ 546 mμ) have been measured, and their concentrations have been calculated, by use of the above formula. The calculated values for vari-

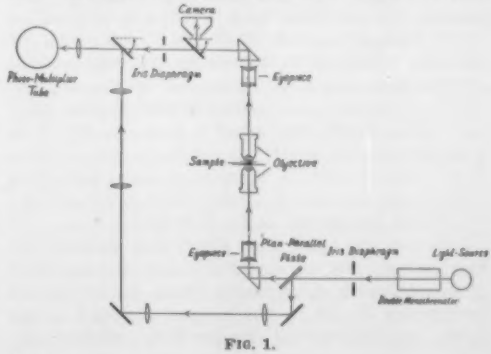

Fig. 1.

[1] The author wishes to extend his sincere thanks to Z. Koana, who has advised him regarding the Schwarzschild-Villiger effect and the method for preventing it, and who has guided him throughout the photometric work. Special indebtedness is due to A. Sibatani, of the Institute for Microbial Diseases, University of Osaka, for the preparation of the specimens, and to G. Kuwabara for help with photometric techniques.

ous spheres agree well with each other and are equal to the value of concentration of the solution before it is suspended, as shown in Table 1, provided the size of the illuminated area is smaller than one third the diameter of the sphere. The result offers proof of the correctness of our theory.

TABLE 1

Diam of sphere (μ)*	Transmittance (%)	Calc conc (*M*)†
2.2	95.4	0.009
3.0	86.6	.020
5.2	71.6	.028
6.0	65.7	.030
7.5	56.6	.031
9.7	52.2	.029
13.5	38.9	.031
22.4	21.1	0.030

* The diameter of the reduced image of the light source formed at the center of a sphere, 2 μ.
† Concentration of the solution before suspension, 0.030 *M*.

The circumstances are not so favorable in the case of nuclei of living cells, as their forms are not always spherical, nor are their contents always uniform. Nevertheless, it can be expected that our method would give better results than those hitherto reported if the specimens be suitably treated so that the nuclei approximate spherical forms.

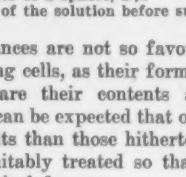

FIG. 2.

An experiment has been performed with this objective in mind. Nuclei from the liver cells of 4 rats were separated by citric acid, as described by Mirsky (*8*), and washed thoroughly with 30% sucrose solution. The nuclei were thus made approximately homogeneous and were then fixed in formalin and stained by the Feulgen reaction. Their DNA content was determined indirectly by measuring the total amount of the regenerated fuchsin—that is, by the measurement of spectral transmittance of each nucleus using our optical system. The result is shown in Fig. 3, in which the amount of DNA in arbitrary units is taken as the abscissa, and the numbers of nuclei containing DNA in the amount of 8.0–8.5, 8.5–9.0, 9.0–9.5 etc., in our unit are plotted as the ordinate.

It can be concluded from Fig. 3 that nuclei of the liver cells of rats are classifiable into at least three groups definitely distinguished from one another by the amount of DNA. The amount for each group shows an arithmetical progression, whereas the

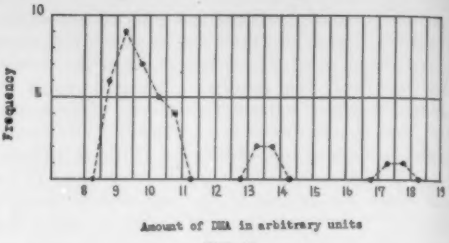

FIG. 3.

amounts found by Swift (*3*), and Lison and Pasteels (*5*) showed a geometrical progression. The relative error of our measurements is 2–3% (number of measurements: 20–32), which is to be compared with the error of measurements by Swift (*3*) and Lison and Pasteels (*5*)—i.e. 7–24% (number of measurements: 36–97). The improvement in accuracy may be attributed to our revised optical system in microspectrophotometry.

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A Medium for the Study of the Bacterial Oxidation of Ferrous Iron[1]

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The study of the bacterial oxidation of ferrous iron in acid mine waters has long been retarded for the want of a suitable synthetic medium.

Prior to the formulation of such an inorganic medium, acid mine waters were used as natural media for the cultivation of the autotrophic bacteria reported by Colmer and Hinkle (*1*), in 1947, and by Leathen and Madison (*2*), in 1949, to be responsible for the rapid oxidation of ferrous iron to the ferric state under acid conditions. Such "natural" media were prepared for use by sterilization, either by autoclaving or by filtration, dependent upon the chemical characteristics of the particular mine effluent.

There were many objections to using such media. The most outstanding were variability of chemical constituents and pH, difficulties of collection and transportation, and sterilization. The medium described here eliminates all these objections and has

[1] This contribution is one of a series of papers by the Multiple Fellowship on Mine Acid Control sustained at Mellon Institute by the Sanitary Water Board, Department of Health, Commonwealth of Pennsylvania.

many distinct advantages, such as uniformity of inorganic constituents, stability during sterilization, excellent keeping qualities, and easily observable growth. To a degree, it is a differential medium. Above all, the medium can be altered to facilitate biochemical and physiological studies of the microorganism. Such studies are now in progress.

The basic medium, the composition of which is as follows, compares favorably with the major chemical composition of acid mine effluents:

Ammonium sulfate [$(NH_4)_2SO_4$]	0.15 g
Potassium chloride [KCl]	.05 "
Magnesium sulfate [$MgSO_4 \cdot 7H_2O$]	.50 "
Dipotassium phosphate [K_2HPO_4]	.05 "
Calcium nitrate [$Ca(NO_3)_2$]	0.01 "
Distilled water	1,000 ml

Sterilization is accomplished by autoclaving for 15 min at 15 psi.

A stock solution of ferrous iron is prepared as follows:

Ferrous sulfate [$FeSO_4 \cdot 7H_2O$]	10 g
Distilled water	100 ml

This solution is sterilized by filtration, using either Berkefeld or Fisher-Jenkins filters. If refrigerated, the solution will remain sterile and without appreciable oxidation for several weeks.

After the autoclaved basic medium cools, 10 ml of the 10% ferrous sulfate solution, per liter of base, is added aseptically. Most often, 100 ml aliquots of the base are placed in 250-ml Erlenmeyer flasks and sterilized. Then 1.0 ml of the ferrous sulfate solution is added aseptically to each flask after cooling. The resultant medium is opalescent and has a pH of about 3.50. Appreciable oxidation does not occur as long as the medium remains sterile.

This medium has been used for over two years in our study of the rapid bacterial oxidation of ferrous iron to the ferric state in acid mine water. Stock cultures of the iron-oxidizing bacteria have been maintained in the medium, without change, throughout the same period.

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Lactic Dehydrogenase and DPN-ase Activity of Blood[1]

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In the course of our studies on the enzymes of the erythrocyte we found that by simply removing the stroma material from the hemolysate from washed red cells the lactic dehydrogenase activity may be increased to about five times that of the stroma-containing hemolysate. This increase in activity was observed both in aerobic experiments with methylene blue, and in anaerobic experiments with ferricyanide, using the method of Quastel and Wheatley (*1*).

These findings have suggested a means of establishing the distribution of the enzymes lactic dehydrogenase and DPN-ase in the blood.

Preparation of stroma-free hemolysate. The red cells are washed four times with a saline-bicarbonate solution and then hemolyzed by freezing and thawing three times. After centrifuging the hemolyzed sample for 20 min at 2,500 rpm (radius of rotor, 13 cm), the sparkling clear supernatant is separated from the precipitated stroma. Dialysis is not necessary if additional nicotinamide is not present during the process of hemolysis. Rabbit blood was used in all the experiments reported here, but the general results have been duplicated with human blood.

Estimation of the dehydrogenase and DPN-ase activity. Into the side bulb of the Warburg reaction flask is introduced 0.2 ml ferricyanide-bicarbonate reagent (*1*). In the main compartment of the flask the following reagents are placed:

1) Sodium cyanide, previously neutralized with HCl, to give a final concentration of 0.05 *M* of CN^- in the reaction medium (*2*).
2) Sodium DL-lactate, to give a final concentration of 0.13 *M* in the reaction mixture.

Other substances may be added as required. In the experiments to be reported here the additional materials indicated in Table 1 were dissolved in the saline-bicarbonate solution. When DPN was added, its final concentration in the reaction medium was 0.865×10^{-4} *M* (determined spectrophotometrically [*3*]). Nicotinamide was added in certain experiments to protect DPN (*4, 5*). The quantity of the liquid in the flask finally was made up to a volume of 2.6 ml with the NaCl-$NaHCO_3$ mixture. The final concentrations of NaCl and $NaHCO_3$ were 0.127 *M* and 0.025 *M*, respectively. Each experimental run included a control vessel from which lactate was omitted. The reaction medium in the flasks was equilibrated at 37° C with a gas mixture containing 95% nitrogen and 5% CO_2. The experiments were run at 37° C and with agitation of the flasks at a rate of 108 oscillations/min. The gas output during the first 5 min was disregarded.

The *Q* values were calculated as follows:

$$Q^{N_2+CO_2}_{\text{lactate}} = \frac{\mu l\ CO_2 \text{ evolved in experimental flask} - \mu l\ CO_2 \text{ in corresponding control flask}}{\text{mg dry-cell residue}}$$

The conditions of the various experiments and the results are indicated in Table 1.

On testing the DPN-ase activity of the fresh stroma-free hemolysate, after the method of Mann and Quastel (*4*) and with added DPN (Expts 4*e* and 4*f*, Table 1), a relatively enormous evolution of CO_2 was obtained whether or not nicotinamide was added (*6*). The volume of gas evolved was many times that obtained by other workers with hemolysates in the presence of

[1] The authors wish to acknowledge the financial support of the Defence Research Board of Canada.

TABLE 1

LACTIC DEHYDROGENASE AND DPN-ASE ACTIVITY IN THE COMPONENTS OF THE BLOOD

Expt No.	Preparation (0.2 ml/flask)	DPN ($0.865 \times 10^{-4} M$)	Nicotinamide (M)	$Q_{lactate}^{N_2+CO_2}$ (μl CO_2 evolved/mg dry-cell residue/hr)
1*a*	Whole blood (fresh)	DPN added	0.01	1.25
2*a*	Washed red blood cells	" "	0.01	2.60
b	Washed red blood cells	Without DPN	0.01	2.60
3*a*	Serum	DPN added	0.01	5.20
b	"	" "	Omitted	5.30
c	"	Without DPN	0.01	2.70
d	"	Without DPN	Omitted	3.00
4*a*	Hemolysate	DPN added	0.02	21.00
b	"	" "	Omitted	5.40
c	"	Without DPN	0.02	4.05
d	"	Without DPN	Omitted	3.29
e	Hemolysate freed from stroma	DPN added	0.02	20.20
f	Hemolysate freed from stroma	" "	Omitted	21.20
g	Hemolysate freed from stroma	Without DPN	0.02	2.14
h	Hemolysate freed from stroma	Without DPN	Omitted	1.95
5*a*	Hemolysate	DPN added	0.02	20.00
b	"	" "	0.01	18.20
c	"	" "	0.05	13.80
d	"	" "	Omitted	5.50

stroma and the absence of nicotinamide. Thus, a recalculation of some of the data in the literature for the dehydrogenase activity of hemolysates (in the absence of nicotinamide), on the weight basis, gives activity values, Q, not greater than 9 μl CO_2/mg dry-cell residue/hr. The majority of values are between 2.5 and 4 μl (*1*). The stroma-free hemolysate, therefore, is practically devoid of DPN-ase. After further study, it was found that rabbit serum itself possesses a marked lactic dehydrogenase activity (Expts 3*a–d*). Every precaution was taken to obtain clear serum free from hemolysate. At the time the authors were not aware that Warburg and Christian (*7*) had already demonstrated the presence of lactic apo-dehydrogenase in the serum of the rat. It was evident, also, from Expts 3*a* and 3*b*, with and without added nicotinamide, that serum has practically no DPN-ase activity.

The dehydrogenase activity of the stroma-containing hemolysates, on the other hand, compared with that of the stroma-free preparation, was found to be very low (Expt 4*b*), but the activity could be restored in such specimens by the simple addition of nicotinamide to give a final concentration of 1 to 2×10^{-2} M (Expt 4*a*). It is apparent from Expts 4*a* and 4*c* that the nicotinamide acts by inhibiting the DPN-ase, and not by participating in the main reaction. That the inhibition is of the competitive type is indicated further in Expts 5*a–d*, in which the amount of nicotinamide was varied. Thus, nicotinamide, in 1×10^{-2} M concentration, produced an almost complete inhibition of the DPN-ase.

It was of interest to investigate also the permeability of the red cells to DPN. As may be observed in Table 1 from the results of Expts 2*a* and 2*b*, with washed red cells, the dehydrogenase activity was not increased by the addition of DPN to the medium. To test whether the failure to activate the dehydrogenase was due to impermeability of the cell membrane to DPN, or to destruction of the coenzyme by contact with, or during passage through, the membrane, another series of experiments was devised as follows:

The lactic dehydrogenase activity of the stroma-free hemolysate (with added DPN, 0.865×10^{-4} M) was measured, (*a*) in the hemolysate alone, (*b*) in the presence of washed red cells, (*c*) in the presence of stroma, and, in each case, with or without the addition of nicotinamide.

Typical results of such experiments are given in Table 2.

Again, the volume of CO_2 evolved by the stroma-free hemolysate (+DPN) alone was very large, amounting to 27 μl/mg dry residue/hr (Expt 6*a*). The addition of nicotinamide caused a slight decrease in the activity of the DPN-ase–free preparation (Expt 6*b*) (*8, 9*). On addition of washed red cells, however, the Q-value was six times greater in the presence of nicotinamide than in its absence (Expts 6*c* and 6*d*). To test whether any hemolysis was likely to occur during the experimental period, a control sample was included in the run, containing the same number of red cells, but no added hemolysate (Expt 6*g*). The same control served also to establish that the formation of pyruvate from lactate by the added red cells during the experiment was negligible ($Q + 0.05$).

The results in the experiments with cell stroma were as anticipated, namely, that the CO_2 production was greatly increased (by more than ten times) in the presence of nicotinamide (Expts 6*e* and 6*f*). It is evident from Expts 6*c* and 6*d* that the DPN is destroyed when in contact with the red cells. In other words, the DPN-ase of the red cell is distributed on the cell surface. Any DPN that may be liberated from the interior on breakdown of the cell likewise is rapidly destroyed on contact with the stroma.

It is probable that DPN-ase is present on the surface of the cells in all tissues, since it is common knowledge that the breakdown of cells by grinding or mincing the tissue leads to complete destruction of

TABLE 2

EVIDENCE FOR THE PRESENCE OF DPN-ASE ON THE SURFACE OF THE RED CELL

Expt No.	Preparation (0.2 ml/flask)	Added materials	Nicotinamide (M)	$Q^{N_2+CO_2}_{lactate}$
a	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	—	—	27.20
b	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	—	0.03	26.00
c	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	Red cell suspension,* 0.05 ml	—	4.25
d	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	Red cell suspension, 0.05 ml	0.03	24.20
e	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	Unwashed stroma,† 0.05 ml	—	1.71
f	Stroma-free hemolysate + DPN $0.865 \times 10^{-4}M$	Unwashed stroma, 0.05 ml	0.03	19.50
g	DPN alone $0.865 \times 10^{-4}M$	Red cell suspension, 0.05 ml	0.03	0.05

* Corresponding to 2.34 mg dry-cell residue per flask.
† Corresponding to 2.67 mg dry-cell residue per flask. The quantity of stroma used was about 10 times that represented by the quantity of cells in *.

the DPN except when an excess of nicotinamide is present (*4, 10–12*).

The evidence for the presence of DPN-ase on the cell surface is not inconsistent with the recent findings of McIlwain (*13*) that the DPN-ase in minced neural tissue preparations is associated with the cell debris.

One important implication of these observations is that DPN as such, cannot exist in the circulating plasma. Other workers (*14*), and the authors, have demonstrated that the coenzyme is not present in the plasma. Even though, as McIlwain (*15*) has shown, the reduced form of the coenzyme ($DPN \cdot H_2$) is not a substrate for DPN-ase, the existence of $DPN \cdot H_2$ in the plasma also is not possible since, in the presence of the plasma lactic dehydrogenase and pyruvate, it would be oxidized and thus be liable to rapid destruction by the red cells.

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Low-Temperature Sterilization of Organic Tissue by High-Voltage Cathode-Ray Irradiation[1, 2, 3]

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Recently a limited number of human tissue banks have been established to preserve blood vessels (*1*), bone (*2*), and cartilage (*3*), since in this way these substances can be made available for transplantation into humans whenever needed. It has been rather difficult, however, to keep these banks supplied with adequate amounts of sterile material since the tissues may often be contaminated before, during, or after removal from the body, at operation or autopsy, and as a result are not safe for transplantation. It is obvious that if a method could be found for sterilizing human tissue without denaturing it, this would be of great value.

The Surgical Research Laboratory of the Children's Medical Center became interested in this broad problem of organic tissue sterilization while attempting to sterilize blood vessels to insure a more constant supply of sterile vascular grafts for human use. In initial experiments attempts were made to decontaminate blood vessel segments with chemical antiseptics (*4*) and complex antibiotic combinations (*5*), but consistently satisfactory or adequate results were not obtained. In 1948 the Department of Food Technology at the Massachusetts Institute of Technology reported the marked bactericidal action of high-voltage cathode-ray irradiation in the sterilization of food (*6*). With the cooperation of John Trump at that institution, irradiation of intentionally contaminated blood vessel segments was carried out using a compact 3-mev electrostatic generator he designed (*7*), which produces high-voltage cathode rays that can penetrate organic material to a depth of 1.5 cm (*8*).

Initially, 125 blood vessel segments that had been

[1] Acknowledgment is hereby made to Kenneth A. Wright, of the High-Voltage Research Laboratory at the Massachusetts Institute of Technology, and to Bernard E. Proctor and Samuel L. Goldblith, of the Department of Food Technology at the Massachusetts Institute of Technology, for their valuable assistance in this work.

[2] The electron sterilization aspects of the work were supported in part by the Atomic Energy Commission.

[3] This work was supported by grants from the American Heart Association and the U. S. Public Health Service.

obtained from dogs were heavily contaminated with a mixture of 24-hr pure cultures, of α-hemolytic streptococcus, β-hemolytic streptococcus, *Staphylococcus aureus, bacillus subtilus, monilia albicans, Escherichia coli, B. proteus,* and *B. pyocyaneus.* They were then sealed in individual polyethylene bags, frozen, and irradiated at carbon-dioxide ice temperature with from 1.5 million to 6.0 million roentgen equivalent physical units (*9*), thawed, and cultured for 7 days in beef heart broth. Of these specimens, only 3 grew out in culture; one had been treated with 2.0 million REP, another with 3.0 million REP, and the third with 5.0 million REP.

Following this, human aortic segments of larger caliber and wall thickness were collected at random, in an unsterile manner, from routine human autopsies that had been performed 6–36 hr post mortem by pathologists at the Massachusetts General Hospital, Peter Bent Brigham Hospital, and the Boston City Hospital. These were individually sealed in polyethylene bags and stored at −50° C. A total of 194 aortic segments was irradiated with 1.5–6.0 million REP. Ninety-four specimens were thawed, irradiated at room temperature, and then cultured; bacterial growth was obtained from three. The remaining 100 vessels were irradiated while still frozen (on dry ice at −80°), then thawed and cultured; two showed persistence of viable organisms. (Frozen but unirradiated controls were thawed, and all were positive when cultured.) These results showed the great effectiveness of cathode-ray irradiation in sterilizing tissue, and they suggested that the temperature of the contaminated tissue during the irradiation did not significantly alter the bactericidal effectiveness of the cathode rays.

Encouraged by these preliminary experiments, we irradiated 5 dog arterial segments at room temperature with 1.5 million REP, the dosage recommended for sterilizing foods. When these arterial grafts were transplanted into recipient animals they did not provide satisfactory vascular pathways, since in each case large occluding thrombi developed in the lumen of the graft and obstructed the blood flow.

Following this thirty-eight unsterile or intentionally contaminated frozen dog aortic segments were irradiated in a dry ice trough at −80° C with 1.5 or 2.0 million REP. Subsequently these blood vessels were transplanted into the abdominal aortas of dogs. In this group of animals there have been no large occluding thrombi, and there has been only one graft failure, that from dehiscence of a suture line because of infection. The remaining 37 vascular transplants appear to have retained their usefulness as grafts.

An additional 22 contaminated arterial grafts were irradiated at low temperatures, with higher dosages ranging from 3.0–6.0 million REP, and were then implanted as aortic grafts in recipient dogs; vessel wall destruction was encountered that became proportionately more marked as the dosage of irradiation was increased (*10*).

Of the 60 unsterile or intentionally contaminated grafts that were irradiated at low temperatures and implanted into animals, only 2 showed any evidence of infection. Apparently, low temperatures had succeeded in protecting vessel walls (in ranges of 1.5–2.0 million REP), but they had not significantly impaired the bactericidal effectiveness of this irradiation.

Recent studies have indicated that ionizing radiations may induce a great variety of chemical reactions, which in turn exert many different biological effects on organic tissues (*11*). The primary or direct action of irradiation on organic molecules is the production of ionization that causes them to undergo degradation, denaturation, or depolymerization. A secondary or indirect action of irradiation is caused by the ionization of intercellular and intracellular water molecules, which leads to the production of free radicals (hydrogen atoms and hydroxyl radicals), which have oxidizing and reducing capabilities (*12*). In the frozen state the diffusion rate of these free radicals is slowed down (*13*). In view of this, and from the results obtained in our experiments, it seems reasonable to assume that by maintaining grafts at low temperature during irradiation, one may succeed in blocking or minimizing those secondary reactions that are so prominent when organic tissue is irradiated at room temperature. In contrast, the degrading, depolymerizing, or denaturing direct action of ionizing irradiation on tissue appears to continue in spite of the frozen state of tissue during irradiation; this results in appreciable organic tissue destruction, which ultimately manifests itself, in the case of blood vessels, when they have been irradiated with dosages above 3.0 million REP.

Fortunately, the direct ionizing action of irradiation accounts for bacterial damage and destruction and is independent of temperature ranges, since it causes ionization in the genes and chromosomes of the microorganisms, which in turn gives lethal mutations or prevents reproduction (*11*).

The experimental findings in the irradiation of canine and human arterial segments already described lend support to these theories, since the microorganisms used to contaminate these arterial segments were destroyed in a very high percentage of cases, regardless of the protective effects of low temperature on the organic tissue.

From the facts at hand it appears that microorganisms are vastly more susceptible to the direct action of relatively low dosages of ionizing irradiation than are the cells that constitute vascular grafts. It is believed that the indirect or secondary action which takes place following the irradiation of the intercellular and intracellular water is not necessary to achieve the destruction of bacteria with a high degree of regularity.

It is apparent that at low temperatures one finds a zone of irradiation dosage which lies above that necessary to sterilize, but which is below that which will cause damage to, the tissues. When infected organic tissue is reduced to a low temperature and irradiated in this zone, bacteria are killed off with a high degree

of effectiveness, and the substance is still fit for use in medicine and surgery.

To date this method of low-temperature sterilization of vascular grafts has been employed in two humans with coarctation of the aorta, in whom the gap remaining in the aorta, after resection of the narrowed portion, could not be overcome by primary anastomosis. Frozen, irradiated aortic grafts (from human autopsy material) have been used in each case to bridge the aortic gap. These two patients have been followed 4 and 6 months postoperatively, and there has been complete relief of hypertension in each. It is believed that this represents the first time that any human organic substance sterilized by high-voltage cathode-ray irradiation at low temperatures has been sucessfully transferred from one human to another.

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Comments and Communications

Krebiozen[1]

Krebiozen is a term applied to an agent of unknown nature alleged to be useful in the treatment of malignant tumors. It is stated to have been discovered by Stevan Durovic, and to have been investigated for clinical activity by A. C. Ivy, head of the Department of Clinical Science, University of Illinois, in collaboration with others. A brochure concerning the agent and the experience with it was circulated as a presentation by Dr. Ivy at a meeting called by him in Chicago on March 26, 1951.[2]

Krebiozen is described as a white powder, soluble in water, mineral oil, and most organic solvents, prepared in an unspecified fashion from the serum of a horse treated in an unspecified way. It is certified as devoid of toxicity and is said to have been capable of restraining the growth of malignant neoplasms in an unstated number of dogs and cats.

The brochure describes the results of the use of Krebiozen in the treatment of 22 patients with various types of cancer. The patients can be divided into three groups on a chronological basis:

1) Seven patients treated during August, September, and October of 1941. Of these six are reported as dead.

2) Seven patients treated between January and June 1950. Two of these are reported as dead and five as living. Of the five, two are described as having early and advanced disease.

3) Eight patients treated between July and December 1950, of whom all are living. Of these, three are described as having early disease, one as having had the cancer removed surgically, and only two as having advanced lesions. In two the degree of extension is not specified.

One patient of Group 1 and three of Group 2, or four at most, of the total 14 individuals can be considered, on the basis of survival, as possibly showing evidence of control of the neoplasm, since eight of the 14 are dead, and two were not in an advanced stage. The period of observation was about a year.

Of the four patients (of the individuals included in the recently treated Group 3) who could, from the data, be regarded as having advanced cancer, the period of observation was only something over four months.

It is evident, therefore, that at the present time we cannot make any certain judgment that the claims on behalf of Krebiozen are valid.

Caution in cases like this is doubly indicated by the well-known fact that the history of the search for better means of cancer control is littered with the hidden wrecks of premature announcements based upon unwarranted conclusions. These cruel and irrevocable disappointments are due, uniformly, to three errors: (1) undue reliance on the subjective response of the patient; (2) unfamiliarity with the course of untreated cancer; (3) failure to require unequivocal objective evidence of an effect of the procedure on the cancer.

The unreliability of the subjective response of cancer patients in classic. Weil stated in 1915:

> It is a curious and interesting fact that almost every therapeutic claim made in recent years in connection with cancer has included among its virtues the relief of pain. . . . In view of this it is probably fair to assume

[1] This communication was solicited by the Editorial Board.
[2] *Krebiozen: An Agent for the Treatment of Malignant Tumors.* Discovered by S. Durovic, M.D.; presentation by A. C. Ivy, Ph.D., M.D. Chicago: Champlin-Shealy Co. Pp. 1-106 (1951).

that the result is in no small measure psychic. The improvement of function is also largely a subjective phenomenon. Improvement in the ability to chew food, to articulate words or to move a limb are familiar phenomena. The victims of this disease seem to be in a very high degree impressionable and respond nobly to every therapeutic effort (*J. Am. Med. Assoc.*, **64**, 1283 [1915]).

The protracted and variable course of untreated cancer is always surprising to those unfamiliar with it. Many medical men, demonstrably most competent in general fields, have been tragically misled by their lack of experience with the long-term care of cancer patients. Furthermore, there is frequently associated with cancer tissue any one of many types of secondary infectious processes. These, by their remissions and exacerbations, closely simulate variations in the course of the neoplasm itself; hence, conclusions based on changes in the apparent size of a neoplasm may be wholly unfounded.

The facts regarding the course of untreated cancer of different sites have been recently reviewed by Shimkin (*Cancer*, **4**, 1 [1951]). Of 100 patients with cancer of the breast, for example, approximately 85 will be alive one year, and 50, two years, from the onset of the disease.

Satisfactory objective evidence of a salutary effect of a potentially therapeutic procedure can be obtained easily for many types of cancer. A diminished level of acid phosphatase in the serum of a patient with cancer of the prostate, for example, provides essentially unequivocal proof that the growth has been restrained. No patients or observations of this type were presented in support of the claims made for Krebiozen.

In studies of cancer therapy, as in every other field of scientific endeavor, controlled and reproducible observations are required before conclusions can be drawn. The use of sham therapeutic procedures in alternate cases of similar clinical types is standard in the hands of experienced and reliable cancer investigators. In the case of Krebiozen, there were no controls reported, the clinical material was not uniform, the results were irregular, the effects were not established as due to the treatment employed, and the subjective responses were those commonly encountered and psychogenic in origin.

From the evidence presented concerning Krebiozen, it is not possible to conclude that it is capable of exerting salutary effect on the course of neoplastic disease in man.

C. P. RHOADS

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I THANK you for calling to my attention the article on Krebiozen solicited from C. P. Rhoads. I agree with everything Dr. Rhoads states in his communication.

I have not stated my position in the Krebiozen picture in order to keep the publicity regarding the substance at an irreducible minimum. This has been the aim of everyone connected with the study. We knew that every time an article, favorable or unfavorable, appeared on the subject, we would be deluged with requests. This has been demonstrated to be true as a result of the unfortunate and sensational publicity that followed a meeting in Chicago on March 26, 1951. This meeting had been planned as a private conference, to be attended only by invitation, for the purpose of presenting what we had seen and of setting up a program of clinical investigation. A leak to the city editors of the various newspapers in Chicago occurred, and the result is now a matter of history.

The booklet referred to by Dr. Rhoads presented the hypothesis of Dr. Durovic, who produced Krebiozen in Buenos Aires, in the pharmaceutical concern owned by his brother. The booklet presented observations regarding the "nontoxicity" and biological assay of the substance. It also included the changes that had been observed to occur up to January 1, 1951, in 22 cancer patients after the administration of Krebiozen. It was prepared for the purpose of indicating that Krebiozen merited a serious clinical study.

I had witnessed most of the changes recorded in the booklet and became convinced that the substance deserved a careful investigation. I felt that it was my duty as a scientist to lend assistance toward ascertaining whether the substance had merit in the management of the cancer patient. I have drawn no other conclusion and have made no other public statement. And, on the basis of what I have seen since January 1, 1951, I, on August 1, 1951, hold the same conviction, namely, that the substance merits further careful clinical investigation.

We know relatively so little about the biology of cancer that no clues should be ignored. The fact that Krebiozen has been distributed for clinical investigation free of charge constitutes unequivocal evidence of the conviction that it may prove to be of value. The implication of that conviction is the only question of any scientific and humanitarian stature.

A. C. IVY

Department of Clinical Science
University of Illinois
Chicago

The National Cancer Foundation has named **Farley W. Wheelwright** executive director. For the past two years Mr. Wheelwright has been on the staff of the Community Service Society of New York.

The American Cancer Society has named **Raymond G. Nebelung** to direct the expansion of the service facilities of the society through its 61 divisions. Dr. Nebelung for the past two years has been clinical instructor in public health and preventive medicine at Stanford University School of Medicine. For four years he directed the Public Health Fund in Honolulu.

News and Notes

Scientists in the News

Visitors at the Communicable Disease Center, USPHS, Atlanta, this month will include **Anant Krishna Anwikar,** Central Province Public Health Service, Nagpur; **Raden Mochtar** and **Julie S. Sulieman,** Ministry of Health, Djakarta, Indonesia; **Zabihollah Ghorban,** Public Health Department of Fars Province, Shiraz, Iran; **Elinar Pedersen,** Norwegian Public Health Service, Oslo; **Tanong Viriyachati,** Ministry of Health, Bangkok.

David R. Bates has left the Physics Department of University College, London, to become professor at Queens University, Belfast. He will continue his work on the upper atmosphere and astrophysics.

Lyle B. Borst has resigned as head of the reactor project at the Brookhaven National Laboratory, to join the faculty of the University of Utah as professor of physics.

Robin C. Buerki has been appointed executive director of Henry Ford Hospital. He has resigned as vice president in charge of medical affairs at the University of Pennsylvania. Dr. Buerki has served as president of the American Hospital Association and the American College of Hospital Administrators, and is now vice president of the National Health Council. He will succeed **Roy D. McClure,** who died March 31.

W. E. Burcham is leaving the Cavendish Laboratory, Cambridge, to become professor of experimental nuclear physics at the University of Birmingham. He will be associated with the university's synchrotron accelerator project.

Ugo Camerini has left the cosmic ray group of the University of Bristol and will spend the coming year at the Center of Nuclear Physics, University of Rio de Janeiro, as a research professor under the auspices of Unesco.

Mark Colburn has been appointed manpower specialist in scientific personnel with the National Security Resources Board. He will help develop and coordinate plans for maintaining an adequate supply of trained technical and scientific manpower to meet the nation's needs in the armed forces, industry, and education. Mr. Colburn comes to NSRB from the Bureau of Naval Personnel.

Edward U. Condon has been appointed director of research and development of Corning Glass Works. His resignation as director of the National Bureau of Standards becomes effective September 30. He replaces **Jesse T. Littleton,** who will become general technical adviser.

Joseph W. Darling, of Philadelphia, has been named chief of the Western European Branch, Foreign Division, National Production Authority, U. S. Department of Commerce. He will assist in the coordination of NPA's production controls and will review foreign requirements for domestic products, recommending the extent to which these needs may be met from U. S. production.

Richard Feinberg, dean of Pacific University College of Optometry, Forest Grove, Ore., for the past three years, has been named dean of Northern Illinois College of Optometry, Chicago. Dr. Feinberg also serves as consultant to the Industrial Hygiene Division, USPHS.

Ira M. Freeman, after completing a 15-months' assignment as program specialist in the Department of Natural Sciences of Unesco in Paris, is returning to resume his duties as associate professor of physics at Rutgers University.

Henry Gilman, of the Iowa State College of Agriculture and Mechanical Arts, has won the 1951 Iowa Award, given by the Iowa Section of the American Chemical Society for meritorious work in research, teaching, or industry.

Gloria C. Gossling has been appointed director of the Museum Education Division of The Franklin Institute. Mrs. Gossling went to the institute last winter as assistant to Armand N. Spitz, who recently resigned to devote himself to the Spitz Laboratories. He will continue his affiliation with the institute as lecturer in the Fels Planetarium.

The International Council of Women Psychologists has honored **Florence L. Goodenough** with a dinner in Chicago. Dr. Goodenough, now professor emeritus, University of Minnesota, in 1946 served as chairman of Section I (Psychology), AAAS. She was the first president of the National Council of Women Psychologists.

Harry E. Gunning, assistant professor of chemistry at Illinois Institute of Technology, has been promoted to associate professor.

Sigmund Hammer, head, Gravity Interpretation Section, Gulf Research & Development Company, has been elected president of the Society of Exploration Geophysicists for the forthcoming year. In addition to his responsibilities with the company, Dr. Hammer is teaching a course in geophysics at the University of Pittsburgh.

Bryn Mawr College has named **Marion Hathway** professor of social economy and director of the Graduate Department of Social Economy and Social Research. Since 1941 Dr. Hathway has been professor of public welfare at the University of Pittsburgh School of Social Work.

Henry W. Kumm has been appointed assistant director of research for the National Foundation for

Infantile Paralysis. Dr. Kumm goes to the National Foundation from the Rockefeller Foundation, where he served as representative in Brazil and other South and Central American countries.

Samuel L. Meyer, formerly professor and head of the Department of Botany at the University of Tennessee, has recently become professor and head of the Department of Botany at Florida State University.

San-ichiro Mizushima, director of research in molecular spectra and structure at Tokyo University, spoke on "Internal Rotation and the Nature of the Hindering Potential in Substituted Ethanes" at the Physics Department's spectroscopy seminar at the Illinois Institute of Technology.

George M. Murphy, consultant and member of the technical information panel, U. S. Atomic Energy Commission, has been appointed chairman of the Chemistry Department of New York University's Washington Square College of Arts and Science. Dr. Murphy succeeds **John E. Vance,** who relinquished the post to devote more time to research and teaching. Professor Vance will continue as head of the Chemistry Department in the Graduate School.

Gerhard W. E. Plaut, formerly a research assistant in the Department of Biochemistry at the University of Wisconsin, has been appointed assistant professor in the Enzyme Institute at Wisconsin. He is retaining a part-time teaching appointment in the Department of Biochemistry.

Sinai Hospital of Detroit, a new hospital now under construction, has announced the appointment of **Julien Priver** as first executive director. Dr. Priver, now associate director of Mount Sinai Hospital of New York, will begin his new duties on Oct. 1.

K. Przibram has retired as director of the Second Physical Institute of the University of Vienna. His successor is **Erich Schmidt,** whose special interests are metal and solid state physics.

Harvey M. Rice has been named president of the State University College for Teachers at Buffalo by the State University of New York's Board of Trustees. He is now president of the Teachers College at Oswego.

Rafael Rodriguez-Molina, governor for Puerto Rico of the American College of Physicians, was re-elected for a new term at the annual meeting of the college held in St. Louis, Mo.

The associates, former students, and friends of **John W. Scott,** professor emeritus of zoology at the University of Wyoming, honored him on his 80th birthday July 1. Lyle S. Powell, of San Diego, James R. Simon, director of Jackson Hole Wildlife Park, and Ralph F. Honess, parasitologist in the Agricultural Experiment Station, former students, were speakers.

Walter M. Scott, assistant chief of the Bureau of Agricultural and Industrial Chemistry, USDA, has recently been elected a fellow of the Textile Institute of Great Britain.

Kansas State College has granted **J. A. Shellenberger,** head of the Department of Milling Industry, three months' leave of absence to serve the Institute of Inter-American Affairs as food and nutrition consultant on cereals for several countries in South and Central America. His first assignment is at Santiago, Chile.

Igor Ivan Sikorsky has been awarded the Daniel Guggenheim Medal and certificate for 1951 "for a lifetime of outstanding contributions to aeronautics, including pioneering with multi-engine airplanes, flying boats, amphibians and helicopters." The award was created in 1928 to honor persons who make notable achievements in the advancement of aeronautics.

George Gaylord Simpson, chairman of the Department of Geology and Paleontology of the American Museum of Natural History, has been in Australia to take part in a conference on "Genetics and Evolution," and to lecture not only in Australia, but also in Egypt and England. While in Great Britain he received honorary degrees from the University of Glasgow, University of Durham, and Oxford University.

Genevieve Stout has been appointed serologist in charge of the USPHS Advisory and Consultative Unit, Venereal Disease Research Laboratory, Chamblee, Ga. Miss Stout assumes her new duties after three years of duty for the Pan American Sanitary Bureau and WHO in Guatemala, where she was awarded a gold medal by the Health Department for "outstanding services as Technical Director of Serology in the Venereal Disease Laboratory and Training Center for Central America and Panama."

C. H. Wadleigh, of the U. S. Salinity Laboratory, Riverside, Calif., has been selected to head the Division of Sugar Plant Investigations in the Bureau of Plant Industry, Soils, and Agricultural Engineering. He succeeds **E. W. Brandes,** who has retired after many years of outstanding work in sugar plant research. At the U. S. Salinity Laboratory during the past 10 years, and at the Arkansas Agricultural Experiment Station from 1936 to 1941, Dr. Wadleigh's investigations have dealt with the mineral nutrition of plants, carbohydrate and nitrogen metabolism of plants, water relations, and salt tolerance.

James L. Whittenberger has been made professor of physiology at the Harvard School of Public Health. As associate professor, Dr. Whittenberger has been head of the school's Physiology Department for four years.

Frank Winton, chairman of the Department of Pharmacology of University College, London, has given a series of special seminars at the University of Texas Medical Branch, Galveston, on intrarenal pressure. Dr. Winton went to Galveston from the recently established University of Jamaica School of Medicine, Kingston, where he assisted in organizational details.

Education

The Foundation for the Scientific Study of Human Problems has been formed in Louisville, Ky., for basic research into "partially studied and unexplored problems of human behavior, independent of, but cooperating with, other organizations." Robert B. Ammons, professor of psychology at the University of Louisville, has been named director of research of the nonprofit organization.

In a program of research sponsored by the **Housing and Home Finance Agency,** the University of Maryland will try to develop criteria for testing alternate and substitute materials in plumbing installations, the University of North Carolina will study urban growth around the new AEC plant on the Savannah River, the University of Pennsylvania will conduct a similar study around the new U. S. Steel works now being built at Morrisville, and Syracuse University will work toward improvement of building code administration. Copies of the booklet *Housing Research,* containing brief, nontechnical descriptions of housing research projects now under way, may be obtained from the Superintendent of Documents, GPO, Washington 25, D. C., at 30 cents per copy.

The **State University of Iowa** has promoted Henry Hamilton, Walter Kirkendall, Paul Seebohm, and Raymond Sheets to assistant professors in the Department of Internal Medicine. William Ames was made associate professor, D. W. Sinton and E. O. Theilen instructors, and Margaret Vance fellow in metabolism. Murray Franklin has resigned to take a position at the University of Illinois.

Among new courses at the **University of Michigan** this fall will be one in drugstore management in the College of Pharmacy, and a vocational industrial curriculum leading to the B. S. in education. The latter is designed to prepare teachers of practical shop skills, teachers of information related to trades or occupations, and coordinators of secondary school cooperative education programs. The Horace H. Rackham School of Graduate Studies has awarded one-year grants totaling $76,431 for the support of 37 research projects by University of Michigan faculty members. Major studies will be in the biological and medical sciences.

The **New York Public Library** has begun microfilming each of the 8,000,000 cards in the public catalogue at the Fifth Avenue building. The work is expected to take about ten months and will cost $25,000. The completed records will occupy only about two cubic feet of storage space somewhere outside the building, where they will be safe from storm, fire, or enemy attack. When this task is completed the library's official catalogue of 4,500,000 cards will be put on microfilm.

The following appointments have been made to the staff of the **University of North Carolina** School of Medicine. Charles H. Burnett as professor and head of the Department of Medicine; William J. Cromartie as associate professor of bacteriology and director of the Bacteriological Laboratory of the University Hospital; Charles B. Taylor as associate professor of pathology; Basil L. Truscott as assistant professor of anatomy; and Clarence M. Miller, Jr., and James B. Caulfield as fellows in pathology.

The **University of Western Ontario** has been bequeathed $100,000 under the will of John B. Maclean, to establish the Michael Francis Fallon Memorial Chair of Clinical Preventive Medicine. George E. Hobbs, assistant dean of the faculty of medicine, has been named to occupy the chair. James A. F. Stevenson, of Yale, has recently been appointed professor and head of the Department of Physiology, succeeding R. L. Noble, who has been named associate head of the Department of Medical Research. Under a grant from the Ontario Cancer Foundation, a radioactive isotope laboratory has been established in the Department of Biochemistry for fundamental research and diagnostic and therapeutic service for Victoria Hospital. A. C. Burton, professor of biophysics, has been awarded renewal of a grant from the Life Insurance Medical Research Fund (USA), and Peter Gaskell has been awarded a fellowship from the fund to carry on research under Dr. Burton. G. E. Hall, president of the university, was recently named a member of the National Research Council of Canada, to serve until March 1954.

Grants and Fellowships

Dental Research Institute of the National Institutes of Health has awarded a total of 25 grants, amounting to $179,878, of which the largest amount went to the University of Chicago for the determination of the value of adding sodium fluoride to a communal water supply and for a study of oral lactobacilli associated with dental caries. New York University received $25,034 for the support of projects on calcification of teeth and bones, x-ray diffraction studies of tooth enamel, and the mechanism of tooth eruption.

A **Ford Foundation** grant of $1,200,000 for a television-radio workshop to produce cultural and public service programs will be under the general supervision of James Webb Young. The programs will be offered without charge to commercial broadcasters who wish to cooperate in the venture, and will be offered for sale to certain commercial sponsors. First show in the project will be the series "The People Act," a continuation of a radio program begun last year by the Twentieth Century Fund.

The NRC Committee on Growth, acting for the **American Cancer Society,** will receive applications for new grants until *Oct. 1.* Investigators already receiving funds will be notified individually regarding extensions. Applications for fellowships in cancer research received prior to *Nov. 1* will be acted upon in December, and those received between *Nov. 1* and *March 1* will be acted upon in April. Availability of Damon Runyon fellowships will be announced later. Application blanks and additional information may be obtained from the Executive Secretary, Committee

on Growth, 2101 Constitution Ave., N.W., Washington 25, D. C.

U. S. Public Health Service grants for cancer research approved in August amounted to nearly 1½ million dollars, all but 40 of the 150 separate grants representing continuations of previously supported projects. The University of California received $44,885 for radiation studies under Horace W. Magoun, and $14,223 for hormone research under Clara S. Roberts, both new projects. Other large grants went to Johns Hopkins ($30,252) for continued study on normal and malignant cells in tissue culture under George O. Gey; to the University of Minnesota ($25,579) for work on the genesis of mammary cancer in mice; and to Sloan-Kettering Institute ($33,821) for radiation studies. Twenty-five special cancer control grants, amounting to $336,621, were also made.

In the Laboratories

Aluminum Company of America will expand its research activities upon completion of a new building at New Kensington, Pa., increasing total floor space at the laboratories by about one third. The building will be ready for occupancy next year. Alcoa has also placed in operation an aluminum reduction plant at Point Comfort, Tex., which is being considerably enlarged, and has applied for permission to begin construction of a smelting plant in Milam Co., Texas, in which lignite will be used for fuel. A new 85,000-ton smelting plant is under construction at Wenatchee, Wash., and a new bauxite refining plant at Bauxite, Ark. Stand-by facilities at Massena, N. Y., and at Badin, N. C., were reactivated late last year.

Under terms of a contract with the Atomic Energy Commission, **American Cyanamid Company** is operating a Mineral Dressing Laboratory at Watertown, Mass., for research on uranium recovery, under the direction of J. Swainson. Under another contract, the company will operate a chemical processing plant at the AEC reactor testing station near Idaho Falls, Idaho, to recover nuclear fuel from used reactor fuel elements. F. Allen Hall will manage this plant.

New appointments to the **Atomic Energy Commission** include Thomas F. Farrell as assistant general manager for manufacturing. General Farrell is on military leave from his post as chairman of the New York Housing Authority. His new responsibilities cover procurement of uranium and other raw materials, processing of feed materials for the production plants at Oak Ridge, Savannah River, Hanford, and Paducah, operation of the production plants, and construction of new production facilities. Donald H. Loughridge, formerly scientific adviser to the Secretary of the Army, has been appointed assistant director of the AEC Division of Reactor Development, in which post he will be chiefly concerned with formulating policies and practices for the coordination of programs at the Argonne National Laboratory, the Knolls Atomic Power Laboratory, and the Oak Ridge School of Reactor Technology. Harold H. Plough has been granted indefinite leave from his position as Harkness professor of biology and chairman of the Department of Biology at Amherst, and has been appointed assistant chief of the AEC Biology Branch, Division of Biology and Medicine. He will assist Paul B. Pearson in the work of sponsoring and developing research on biological effects of radiation and the application of atomic energy products to genetic and physiological problems.

McNeil Laboratories, Philadelphia, has appointed Joseph Sam senior scientist in the Department of Organic Chemistry, where he will work on the synthetic organic research activities of the company.

Merck & Co., Inc., has announced the appointment of Karl Folkers, Max Tishler, and J. C. Woodruff as associate directors of the Research and Development Division. Dr. Folkers has been concerned with research in nutrition and chemotherapy, Dr. Tishler with developmental research, and Mr. Woodruff with microbiological research.

Robert H. Kittner, production manager of the Industrial Rayon Corporation at Cleveland, has joined the General Development Department of **Monsanto Chemical Company.** John J. Healy, Jr., of Brookline, Mass., has been appointed assistant to Carroll A. Hochwalt, vice president in charge of research, development, and patents.

W. W. Bell and W. G. Bywater have been elected vice presidents of **S. B. Penick & Co.,** drug and chemical manufacturers. Dr. Bywater has headed the research division of the company since 1945. Mr. Bell has specialized in botanical drug production.

Miscellaneous

Chemicals wanted by the Registry of Rare Chemicals, 35 W. 33rd St., Chicago 16, Ill., are: tantalum nitride; zirconium silicide; tungsten carbonyl; boron nitride; iodine heptafluoride; carboxylbenzoquinone; thiobenzoic acid; vinylcyclobutane; isophthalaldehyde; D-mannonic acid; 2-nitro-4-aminotoluene; 5-methylheptanol-3; ethylsulfinic acid; 1-chloro-2-bromoethylene; 6-carboxyl-2-naphthylamine; L-fucose; leucylglycylglycylglycine; α-thujene; argininic acid; and cholesteryl linoleate.

The following **Point 4** technical appointments have been announced: Talmage E. Duncan, agricultural engineer, and Lewis E. Long, farm management specialist, Training Center for Rural Engineering, Fazenda Ipanama, Brazil; Ernest W. Laake, entomologist, Costa Rica; Francis A. Ralston, animal husbandman, and George Stewart, agronomist, Iran; Murl McDonald, extension specialist, Beirut, Lebanon; Carl C. Blickenstaff, entomologist, Thomas S. Buchanan, forest pathologist, and Frank G. Davis, economist, Liberia; Ralph B. Swain, entomologist, Nicaragua; Charles W. Carlston, geologist, Pakistan; R. P. Bartholomew (with seven associates from the Arkansas Agricultural Experiment Station), Panama; and D. S. Hubbell, agronomist, Peru.

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118th AAAS MEETING

Philadelphia, December 26-31, 1951

The list of hotels and the reservation coupon below are for your convenience in making your hotel room reservation in Philadelphia. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Philadelphia and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **Share a room with a colleague if you wish to keep down expenses.** Mail your application *now* to secure your first choice of desired accommodations.

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DRAKE	$6.00	$ 7.00	$ 9.00	$15.00
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Cots added to a room are $2.50 each; dormitory style rooms (for 5 or more) are $3.50 per person.

★ Hotels starred have sessions in their public rooms. For a list of the headquarters of each participating society and section, please see Association Affairs, *Science*, August 24, or *The Scientific Monthly*, September.

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(Please print or type)

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(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

Publications Received

Blood Clotting and Allied Problems. Transactions of the Third Conference, January 23–24, 1950. Joseph E. Flynn, Ed. New York: Josiah Macy, Jr. Foundation, 1950. 224 pp. $3.00.

Adsorption et Cinétique Hétérogène, XIX. Colloques Internationalaux du C.N.R.S., 12–17 Septembre 1949. Paris, France: Centre National de la Recherche Scientifique, 1950. 281 pp.

Elements of Optical Mineralogy: Description of Minerals, Part II. 4th ed. Alexander N. Winchell with collaboration of Horace Winchell. New York: Wiley; London: Chapman & Hall, 1951. 551 pp. $12.50.

A Hundred Years of Physics. William Wilson. New York: Macmillan; London: Gerald Duckworth, 1950. 319 pp. $3.50.

Physical Chemistry: Experimental and Theoretical; An Introductory Text-book. G. van Praagh. New York: Cambridge Univ. Press, 1950. 295 pp. $2.75.

An Introduction to the Science of Photography. Katherine Chamberlain. New York: Macmillan, 1951. 292 pp. $4.75.

The Ego and the Self. Percival M. Symonds. New York: Appleton-Century-Crofts, 1951. 229 pp. $2.50.

Functional Anatomy of the Limbs and Back. A Text for Students of Physical Therapy and Others Interested in the Locomotor Apparatus. W. Henry Hollinshead. Philadelphia-London: Saunders, 1951. 341 pp. $6.00.

Coefficient Regions for Schlicht Functions. A. C. Schaeffer and D. C. Spencer. New York: American Mathematical Society, 1950. 311 pp. $6.00.

Soils: Their Origin, Constitution and Classification. 3rd ed. Gilbert Woodring Robinson. London: Thomas Murby; New York: Wiley, 1949. 573 pp. $5.00.

Pharmacology. 2nd ed. Oxford Medical Outline Series. Michael G. Mulinos. New York: Oxford Univ. Press, 1951. 484 pp. $5.00.

Symposium on the Healthy Personality. Transactions of Special Meetings of Conference on Infancy and Childhood, June 8–9 and July 3–4, 1950. Milton J. E. Senn, Ed. New York: Josiah Macy, Jr. Foundation, 1950. 298 pp. $2.50.

Science German Course. 4th ed. C. W. Paget Moffatt; revised by Joseph Horne. New York: Academic Press; London: University Tutorial Press, 1950. 311 pp. $2.25.

Laboratory Manual of Elementary Organic Chemistry. 2nd ed. George Holmes Richter. New York: Wiley; London: Chapman & Hall, 1951. 146 pp. $1.80.

The Education of Man: Aphorisms. Heinrich Pestalozzi. New York: Philosophical Library, 1951. 93 pp. $2.75.

Scientists at War. Wilfrid Eggleston. New York: Oxford Univ. Press, 1950. 291 pp. $4.00.

Laboratory Manual for Brief College Chemistry. Rev. ed. Leon B. Richardson and Andrew J. Scarlett. New York: Holt, 1951. 229 pp. $2.00.

The Engineering Method. Reprinted from "The Engineering Profession." John Charles Lounsbury Fish. Stanford, Calif.: Stanford Univ. Press, 1950. 186 pp. $3.00.

Orthopaedic Nursing. Frederick J. Knocke and Lasalle S. Knocke. Philadelphia: F. A. Davis, 1951. 682 pp. $5.00.

British Medical Bulletin: Industrial Hazards, Vol. 7, Nos. 1–2, 1950. Copies obtainable from Oxford Univ. Press, New York. 144 pp. $2.00.

Meetings & Conferences

Sept. 25–28. American Roentgen Ray Society. Washington, D. C.

Sept. 25–28. American Society of Mechanical Engineers (Fall). Hotel Radisson, Minneapolis.

Sept. 26–28. National Metal Trades Association. Palmer House, Chicago.

Sept. 29. Society for Clinical and Experimental Hypnosis (Annual). New York Academy of Sciences, New York.

Sept. 29–Oct. 5. American Society for Metals. Detroit, Mich.

Sept. 29–Oct. 5. American Welding Society. Detroit, Mich.

Oct. 1–3. Association of Official Agricultural Chemists. Shoreham Hotel, Washington, D. C.

Oct. 3–4. Association of American Feed Control Officials. Shoreham Hotel, Washington, D. C.

Oct. 3–5. American Institute of Mining and Metallurgical Engineers (Annual). Oklahoma Biltmore, Oklahoma City.

Oct. 3–6. National Society for Crippled Children and Adults (Annual). Palmer House, Chicago.

Oct. 4–6. American Physical Society, Division of Electron Physics. Conference on Gaseous Electronics, G-E Research Laboratory, Schenectady, N. Y.

Oct. 5. American Crystallographic Association, Michigan chapter. University of Michigan, Ann Arbor.

Oct. 5. Association of American Fertilizer Control Officials. Shoreham Hotel, Washington, D. C.

Oct. 5. National Noise Abatement Symposium (Annual). Technology Center, Chicago.

Oct. 6. Association of Economic Poison Control Officials. Shoreham Hotel, Washington, D. C.

Oct. 8–10. American Forestry Association and the Society for the Protection of New Hampshire Forests (Annual). Jefferson, N. H.

Oct. 8–10. The American Oil Chemists' Society (Fall). Edgewater Beach Hotel, Chicago.

Oct. 9–11. American Meteorological Society. Minneapolis.

Oct. 10–12. Porcelain Enamel Institute. Ohio State University, Columbus.

Oct. 15–17. American Gas Association (Annual). Kiel Auditorium, St. Louis.

Oct. 15–18. American Dental Association (Annual). Washington, D. C.

Oct. 15–19. National Metal Congress and Exposition. Detroit.

Oct. 15–19. Society of Motion Picture and Television Engineers (Fall). Hollywood Roosevelt Hotel, Hollywood, Calif.

Oct. 15–19. World Metallurgical Congress (Annual). Detroit, Mich.

Oct. 18–20. American Chemical Society and Southern Association of Science and Industry, Southwide Chemical Conference. Wilson Dam, Ala.

Oct. 18–20. National Association of Corrosion Engineers (Regional). Corpus Christi, Tex.

Oct. 20–21. Way of Science Conference (Annual). Roosevelt College, Chicago.

Oct. 20–26. First Pan American Congress on Veterinary Medicine. Lima, Peru.

Oct. 22–23. Independent Petroleum Association of America (Annual). The Shamrock, Houston, Tex.

Oct. 22–24. American Association of Blood Banks (Annual). Hotel Nicollet, Minneapolis.

Oct. 22–24. American Standards Association (Annual). Waldorf-Astoria, New York.

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Biochemist, Organic and Physical Minors, Ph.D. 1942. Experience includes tracer techniques, animal and tissue metabolism and nutrition, medical applications. Now Assistant Professor Johns Hopkins. Box 10, SCIENCE. 9/28, 10/12

Biologist: Young man, A.B., M.S., 3 years teaching experience. Desires teaching or research position. Box 8, SCIENCE. X

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Research Physiologist (plant or mammalian) with experience in use of Warburg Apparatus. Send full particulars. I. Rosenfeld, University of Wyoming, Laramie, Wyoming. 9/14

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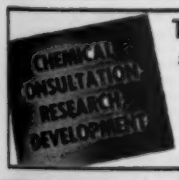

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* Fishman, W. H., et al., J. B. C. 173, 449 (1948).
† Corcoran, A. C., et al., J. Lab. & Clin. Med., 36, 297 (1950).

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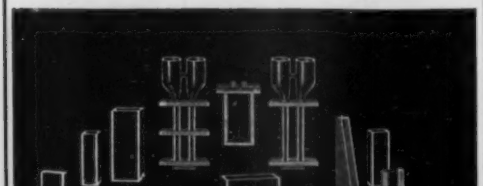

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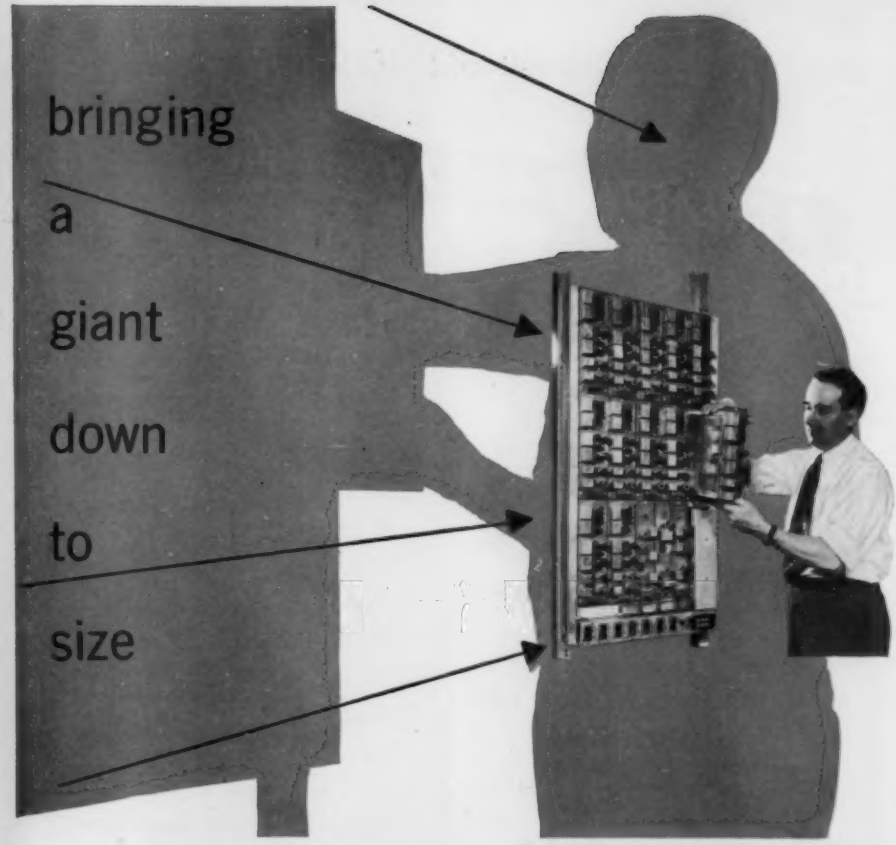

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